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Digital Health Innovations in Supporting Healthy Aging: An Epidemiological Perspective: A Literature Review

Nurul Amalliah[1*]

[1]Magister Of Public Health,Faculty Of Public Health, Halu Oleo University, Kendari, Indonesia

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Abstract

The development of digital health technology has presented great opportunities in supporting healthy aging amid the increasing number of elderly people. Healthy aging has become an important agenda in the public health system, especially in the era of digital disruption. This study aims to explore the impact of digital innovations, such as telemedicine, wearable health devices, health apps, and artificial intelligence, on the health of the elderly. The method used is a literature review of national and international journals published between 2020 and 2025 that are relevant to the topics of digital health and aging. Each piece of literature was evaluated based on its methodology, results, and contribution to the epidemiological understanding of digital interventions for the elderly. The results indicate that digital technology has great potential in improving the early detection of chronic diseases, expanding access to healthcare services, and promoting the independence of the elderly. However, digital and technological literacy remain major challenges that need to be addressed through interdisciplinary approaches and inclusive policies. Conclusion This study underscores the need to strengthen epidemiological research to comprehensively assess the effectiveness of digital interventions in support of sustainable healthy aging.

Correspondence Address:
Jl.HEA. Mokodompit, Anduonohu, Kendari, Sulawesi Tenggara, Indonesia
E-mail: amalliahnurul03@gmail.com

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Introduction

Aging is a natural process that cannot be avoided, but the quality of life in old age can be improved through appropriate health interventions. Global phenomena show a significant increase in the number of elderly people. According to the World Health Organization (WHO), the world's population aged over 60 is predicted to reach 2 billion by 2050 (WHO, 2015). In Indonesia alone, based on data from the Central Statistics Agency (BPS) in 2023, the elderly population has increased to 10.48% of the total population. This situation poses a major challenge to the healthcare system because the elderly are vulnerable to chronic diseases such as hypertension, diabetes, heart disease, and dementia (Kliegman, Marcdante, & Behrman, 2021).

As digital technology advances, various health innovations are being developed to accommodate the needs of the elderly population. The concept of “digital health” encompasses the use of information and communication technology in the form of mobile applications, telemedicine, Artificial Intelligence (AI), Internet of Things (IoT), and wearable devices to improve the effectiveness and efficiency of healthcare services (James & O'Neill, 2021). These innovations not only simplify access to healthcare services but also enable real-time health monitoring, self-directed education, and data-driven decision-making (Smith & Green, 2019).

The application of digital technology in supporting healthy aging can be seen from an epidemiological perspective, namely through studies of the patterns, causes, and effects of health technology use in the elderly population. Epidemiology, as a basic science in public health, plays an important role in identifying determinants of elderly health and evaluating the effectiveness of technology-based interventions (Sari, Akbar, & Kamaruddin, 2021). However, the implementation of digital health technology is not without challenges. Issues such as digital literacy, access gaps, data

privacy, and cultural acceptance pose serious barriers, particularly for older adults who are not accustomed to using digital devices (Greenhalgh & Abimbola, 2021). Therefore, an evidence-based approach through epidemiological studies is necessary to comprehensively assess the benefits and risks of digital health innovations for the elderly population. Based on this, the purpose of this literature review is to present digital innovations, such as telemedicine, wearable health devices, health applications, and artificial intelligence, in supporting the health of the elderly.

Methods

This study uses a systematic literature review approach based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to identify, evaluate, and synthesize various results of previous research related to the utilization of digital technology in supporting healthy aging. This approach was chosen to identify, evaluate, and synthesize scientific evidence regarding the effectiveness of digital health innovations in supporting healthy aging from an epidemiological perspective.

Data sources were obtained through a search of scientific articles from several trusted databases including Google Scholar, PubMed, and Science Direct. The keywords used in the search process include combinations such as ("Digital Health Innovation" OR "mHealth" OR "Telemedicine" OR "Wearable Devices" OR "Artificial Intelligence") AND ("Healthy Aging" OR "Elderly" OR "Older Adults") AND ("Effectiveness" OR "Health Outcomes"). The selected articles were published within a specific time frame from 2020 to 2025, written in English, and contain relevant empirical research results (both quantitative and qualitative) related to the study topic. The inclusion and exclusion criteria set in this study include:

Table 1. Inclusion and Exclusion Criteria

Aspect	Inclusion	Exclusion
Type of study	Original research articles (quantitative, qualitative, mixed-method, RCT, cohort, cross-sectional, quasi-experimental), systematic reviews, scoping reviews.	Editorials, opinions, short reports, conference abstracts without full text, study protocols.
Population	Elderly (≥60 years) or studies involving adult subjects with subgroup analysis of the elderly	Study with a population of children, adolescents, or young adults without elderly data.
Intervention	Digital health innovations: telemedicine, mHealth, health applications, wearable devices, AI, health IoT	Non-digital or conventional-based interventions only
Accessibility	Full text articles, accessible for free	Paid article/unavailable full-text
Relevance	A study evaluating the effectiveness or impact of digital innovation on healthy aging (clinical indicators, functional, quality of life, health behavior, epidemiology).	Articles that are not relevant to the topic of digital innovation & healthy aging

Selection Process

1. Identification, Search results from the database are exported to a reference manager, then deduplication is performed.
2. Screening, Titles and abstracts are screened based on inclusion-exclusion criteria.
3. Eligibility, The full text of potential articles is reviewed in detail.
4. Inclusion, Articles that meet the criteria are included in the literature synthesis.

The PRISMA flow diagram is used to show the number of articles that were identified, screened, excluded, and finally analyzed. The synthesis is carried out narratively thematically with grouping based on types of digital health innovations and their impact on healthy aging indicators.

Results

In the study selection process, the PRISMA 2020 guidelines were used to develop the article identification and screening flow. A total of 50 articles were identified. After removing duplicates and initial screening based on titles and abstracts, 45 articles remained for further screening. Of these, 15 articles were excluded because they were irrelevant, leaving 30 articles to proceed to the full-text search stage. However, 14 reports could not be accessed in full, leaving 16 articles to be assessed for eligibility. After a thorough evaluation, 6 articles were excluded for several reasons, namely that the participants were not elderly and the study design did not meet the inclusion criteria. Finally, 10 main studies were found to meet the criteria and were included in this systematic review. This is shown in the table below:

Table 2. Systematic Review

No.	Autor / Year	Title	Methods	Results
1	Yan *et al*. / 2024	Patient motivation as a predictor of digital health intervention effects: Ameta-epidemiological study of cancer trials	Meta-epidemiology of 27 RCTs with 3 motivation indicators	High motivation increases the effectiveness of interventions. Dropout rates are higher in groups with low attachment to service providers.
2	Adauy et al / 2024	Navigating Through Innovation in Elderly's Health: A Scoping Review of Digital Health Interventions	Scoping review of 421 documents (1988–2022), PRISMA and JBI methods	93% of initiatives focus on the elderly, mostly for monitoring, education, and telemedicine; limited implementation in developing countries
3	Ungvari et al. / 2024	Social Support and Compliance The Semmelweis Study: a longitudinal occupational cohort study within the framework of the Semmelweis Caring University Model Program for supporting healthy aging	Longitudinal cohort study of 8,866 university staff, data collected every 5 years	Providing important data for work-based healthy aging policy interventions. Focusing on the detection of unhealthy aging and the improvement of cognitive, social, and biological functions.
4	Fitriahadi et al / 2024	Enhancing non-communicable disease detection and education among elderly	Collaborative counseling & screening with midwives and Aisyiyah cadres	The screening results showed that 71.43% of the elderly experienced hypertension, 34.39% were diagnosed with hyperglycemia, and 34.43% had blood sugar levels above 200 mg/dl. The elderly diagnosed with hypertension, diabetes mellitus, or at

No.	Autor / Year	Title	Methods	Results
				high risk of other NCDs are advised to undergo further monitoring and examination at nearby healthcare facilities.
5	Riesty et al/ 2023	Screening and Counseling for Non-Communicable Diseases as the Initiation of the Elderly Posyandu Program in Turi District, Sleman	Examination of 49 elderly people (blood pressure, GDS, waist circumference), counseling by the community health center.	The examination results indicate that the majority of the elderly (73.3%) suffer from hypertension, while 6.1% (three people) are diagnosed with hyperglycemia. Additionally, 42.9% of the elderly have a waist circumference exceeding the normal average, which increases the risk of health disorders.
6	Khoirunisah et al / 2024	Analysis of Digital Health Services in Realizing Smart Cities in Indonesia	Systematic literature review, ideal types methods, and SWOT analysis	Implementation disparities between regions; digital services are concentrated in western and central Indonesia. Main challenges: infrastructure, digital literacy, and socio-cultural readiness.
7	Arifah et al / 2024	The Utilization of Digital Technology in Improving Healthcare Services	Literature review on 8 journals related to digital technology and health services	Digital technology accelerates administration, enhances diagnosis, and expands access

No.	Autor / Year	Title	Methods	Results
				to remote areas. It improves the efficiency of the health system in an inclusive and sustainable manner.
8	Maruf et al / 2023	Empowering Students for Enhancing Health Literacy and Digital Health Literacy Related to Covid-19	Pre–post test of online training	Knowledge increases, digital literacy decreases slightly.
9	Zoltán Győrffy/ 2023	Older Adults in the Digital Health Era: Insights from a Representative	A representative survey of the population aged 65 years and older in Hungary to investigate the patterns of use and attitudes towards digital health technology.	Most respondents are aged 65–74 years old and 74% aged 75 and above have used more than one digital health device. About 70% from both age groups have a positive attitude towards this technology.
10	Yip Tsai, et al. / 2024	Digital Health Interventions for Promoting Healthy Aging and Cognitive Health	A systematic review to evaluate the effectiveness of digital health interventions in facilitating healthy aging and cognitive health in the elderly.	Digital health interventions show potential in supporting healthy aging and cognitive health in the elderly, but further research is needed to identify the considerations for their application.

Discussion

Digital health uses routine and innovative forms of information and communication technology to meet health needs and provide effective health interventions remotely. In the last decade, digital health innovations such as telemedicine, mobile health applications, wearable devices, and the integration of health big data have increasingly been viewed as potential strategies to support healthy aging. From an epidemiological perspective, this approach not only focuses on clinical interventions but also on monitoring disease patterns, risk factors, and evaluating the effectiveness of population-based programs.

1. Telemedicine and Telehealth

Telemedicine and telehealth are the most widely adopted digital health innovations in recent years, especially since the COVID-19 pandemic accelerated the transformation of healthcare services. A study (Snoswell et al., 2020) shows that telemedicine not only expands access to healthcare services for the elderly, particularly those living in remote areas or with mobility

limitations, but also contributes to the overall efficiency of the health system. From an epidemiological perspective, the existence of telehealth allows for the early detection of risk factors for chronic diseases such as hypertension, diabetes, and heart failure, which often require intensive follow-up. With remote consultations, regular monitoring can be conducted without having to wait for acute conditions that lead to hospitalization. This implies a decrease in the number of preventable hospitalizations, an important indicator in health service epidemiology, which shows that preventive interventions can prevent the worsening of diseases. Telemedicine also reduces transportation costs, increases adherence to control measures, and supports the integration of elderly health data into the national surveillance system, so that chronic disease patterns can be better monitored at the population level.

2. Application Mobile Health (mHealth)

In addition to telemedicine, mobile health (mHealth) applications are rapidly developing as more personalized and user-oriented smartphone-based interventions. A meta-analysis by (Marcolino et al., 2019) found that mHealth is effective in improving the control of major chronic diseases in older adults, particularly hypertension and diabetes, as well as encouraging increased physical activity. From an epidemiological perspective, these applications play an important role in modifying risk factors, as they can improve medication adherence, facilitate medication reminders, and provide evidence-based education on healthy lifestyles. Older adults who previously had difficulty accessing health information can now use simple applications to monitor their blood pressure, blood sugar levels, or daily step count. In the context of the population, data collected from mHealth applications can be analyzed as a form of digital epidemiology, which is the use of digital data to monitor public health trends, while (Yan et al., 2024) through a meta-epidemiological study stated that patients' intrinsic motivation has a major influence on the effectiveness of mHealth-based digital interventions in cancer patients. From 27 randomized controlled trials (RCTs), it was found that the group with high motivation levels experienced a significant improvement in quality of life (QoL), while those with low motivation tended to drop out of the program. The three motivation indicators used were: patient expectations, pre-allocation engagement, and level of trust in service providers. This study concluded that patients' initial motivation is crucial for program success and should be measured from the early stages of participant recruitment.

Therefore, mHealth is not only beneficial at the individual level, but also serves as an important tool for understanding the distribution of risk factors in the community, which can be used as a basis for prevention and health promotion policies. Therefore, mHealth is not only beneficial at the individual level, but also serves as an important tool for understanding the distribution of risk factors in the community, which can be used as a basis for prevention and health promotion policies.

3. Wearable Devices dan Pemantauan Jarak Jauh

Another significant innovation is the use of wearable devices, such as smartwatches or biometric sensors, which enable real-time health monitoring. Research (Patel et al., 2021) shows that wearable devices are effective in monitoring physical activity, sleep quality, and heart rate, which are strongly correlated with the prevention of metabolic syndrome, obesity, and cardiovascular disorders in older adults. From an epidemiological perspective, wearable devices serve as public health monitoring tools, where the data collected can be used to detect patterns of activity, sleep disorders, and physical decline in the elderly population. This makes wearable devices not only individual monitoring tools but also sources of aggregate data that enrich population epidemiological studies. With an early warning system, for example, if an abnormal heart rate is detected, clinical intervention can be carried out before the condition develops into serious complications. (Fitriahadi et al., 2024) conducted screening and education activities on non-communicable diseases (NCDs) among the elderly in Sendangsari Village. Screening results showed that 71.43% of participants had hypertension, and over 34% had high blood sugar levels. This activity also involved measuring blood pressure, random blood sugar levels, and providing education on healthy lifestyles. The program proved effective in increasing the elderly's awareness of health and the importance of early detection. Strengthening collaboration between health cadres, medical personnel, and the local community is key to the sustainability of NCD detection programs at the community level.

The community service activities carried out by (Riesty et al., 2023) aimed to detect non-communicable diseases (NCDs) early and provide health education to elderly people in Dadapan and Selowangsan hamlets, Turi District, Sleman. Screening results of 49 elderly people showed that 73.3% had hypertension, 6.1% were diagnosed with hyperglycemia, and 42.9% had waist

circumferences exceeding the normal threshold. Education was provided directly by the team with the involvement of the Community Health Center, cadres, and village officials. Elderly people who were detected as being at high risk received referral letters for further examination at health facilities. This activity is the first step toward establishing an Elderly Health Post in the area, which has not been available until now. Therefore, remote monitoring through wearable devices enables healthcare workers to take a proactive approach, thereby reducing unnecessary hospital visits and maintaining the quality of life of the elderly for a longer period of time.

4. Big Data, AI, and Epidemiological Analysis

   A scoping review study by (Hirmas-Adauy et al., 2024) examined 421 documents related to digital health interventions for older adults and caregivers. The majority of studies came from high-income countries, focusing on monitoring, prevention, and treatment of chronic diseases such as hypertension, diabetes, and dementia. The dominant technologies used were mobile phones, computers, and wearable devices. Most interventions were still in the trial and validation stages. Only a small proportion had reached the stage of widespread implementation. Although the effectiveness was reported to be positive in the majority of cases (86.9%), this review emphasized the importance of further research in developing countries to evaluate the effectiveness and sustainability of digital health implementation in vulnerable groups.

   The development of digital technology does not stop at monitoring individuals, but also extends to the use of big data and artificial intelligence (AI) to support predictive epidemiological analysis. As explained by (Topol 2019), the integration of AI into healthcare systems enables highly personalized interventions. Through machine learning algorithms, data from Electronic Health Records (EHR), mHealth applications, and wearable devices can be combined to predict the risk of falls, dementia, and cardiovascular disease in the elderly. From an epidemiological perspective, this represents a significant transformation: analysis is no longer merely descriptive but also predictive and prescriptive. AI is capable of identifying complex patterns that are difficult to capture with conventional methods, such as multifactorial relationships between lifestyle, genetics, and the environment. Furthermore, epidemiological big data can be used by policymakers to optimize healthcare resources, target interventions at vulnerable groups, and evaluate the impact of health programs in real-time. Thus, the use of big data and AI makes geriatric epidemiology increasingly dynamic, adaptive, and prevention-oriented, rather than merely therapeutic.

This article highlights how digital health interventions can be a solution to the healthcare service gap for the elderly, especially in remote areas. Interventions such as telemedicine, personal health tracking, and digital reminder systems have proven capable of improving communication between patients and healthcare providers, as well as enhancing the independence of the elderly in monitoring their health. However, challenges such as the digital divide, limited technology literacy among the elderly, and the lack of long-term evaluations are important considerations. The design of future digital interventions must take into account accessibility and ease of use to optimally reach the elderly population (Hirmas-Adauy et al., 2024).

Conclusion

Digital health innovations such as telemedicine, health applications (mHealth), wearable devices, and the use of big data and artificial intelligence have proven to have great potential in supporting healthy aging. These technologies can improve early detection of chronic diseases, expand access to healthcare services, facilitate real-time health monitoring, and promote elderly independence. From an epidemiological perspective, digital interventions play a crucial role in monitoring disease patterns, risk factors, and the effectiveness of health programs among the elderly population. However, challenges such as the digital divide, low technology literacy among the elderly, infrastructure limitations, and data privacy issues remain major obstacles. Therefore, a multidisciplinary approach, inclusive policies, and further epidemiological research are needed to ensure the effectiveness and sustainability of digital health interventions in supporting the quality of life of the elderly.

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