RESEARCH PAPER

Assessing the Role of Digital Health Technologies in Minimizing Cardiac Healthcare Costs for India's Aging Population: A Study in the Delhi Region

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ABSTRACT

The increasing burden of cardiovascular disease among India's aging population, particularly in the form of high out of pocket expenses (OOP), is exerting significant economic pressure. With the rapid expansion of digital health technologies, including teleconsultations, remote monitoring devices, electronic health records and digital payment systems, there is growing interest in their potential to reduce healthcare costs and improve access to timely cardiovascular care. This study examines the effect of digital health tools on reducing cardiovascular OOP expenditure among older adults in the Delhi region. Using a mixed methods design that combines quantitative surveys of older heart patients with qualitative interviews of healthcare professionals, the research analyzes how digital health adoption affects medical visits, drug costs, clinical expenses, acute episodes and care adherence. The findings are expected to provide insight into the affordability, availability and effectiveness of digital health technologies in the treatment of cardiovascular disease. The study aims to provide evidence to policy makers and healthcare providers about integrating digital interventions to reduce financial vulnerability among the aging population.

Keywords: Digital health technologies, cardiac healthcare costs, out-of-pocket expenditure, elderly population, telemedicine.

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INTRODUCTION

Digital health technologies are playing an important role in reducing cardiovascular health care costs for India's aging population, especially in urban areas like Delhi, where the burden of cardiovascular disease is high and cost remains a major barrier to care (Gupta et al., 2022; IIPS et al., 2020). For older patients, cardiovascular care often includes recurring costs related to consultations, diagnostic tests, medications, emergency care and long-term disease management (Gupta et al., 2022). Digital health tools including telemedicine platforms, wearable monitoring devices, electronic health records, mobile health applications, and AI-based decision support systems help reduce these costs by preventing avoidable complications, enabling timely intervention, and streamlining routine care (Harikrishnan et al., 2024).

The most important contribution to digital health technology is the reduction in hospital visits through teleconsultation services. Instead of physically visiting cardiologists for follow-up appointments, elderly patients can consult specialists online, thereby reducing travel expenses, hospital fees and care costs. This is especially valuable in Delhi where many elderly people depend on family support for mobility. Telemedicine reduces the need for emergency visits by enabling rapid professional advice at the early onset of symptoms (IIPS et al., 2020). Portable and home-based monitoring devices – such as digital blood pressure monitors, wearable EKG devices and smartwatches – allow continuous monitoring of vital cardiac parameters (Bakker et al., 2025). This reduces the frequency of clinic-based tests and helps in the early detection of anomalies. Early detection reduces the risk of hospitalization, thereby reducing expensive emergency admissions and intensive care costs (Bhattarai et al., 2020). In addition, mobile health apps that track medication adherence, diet, exercise, and symptom patterns help older patients better manage their conditions, thereby reducing relapse and the subsequent financial burden (Chakraborty et al., 2019).

Digital health systems also reduce treatment costs by improving efficiency. Online pharmacies offer discounted cardiovascular medications, digital platforms offer affordable diagnostic packages, and health apps help patients compare prices for procedures, tests, and

providers (Athavle, 2024). Insurance-related digital portals simplify claims and guide patients towards government-backed schemes like PM-JAY or Delhi Public Health Schemes, thereby enabling financial security for the low-income elderly population (IIPS et al., 2020).

In addition, digital technologies strengthen care coordination between cardiologists, primary care physicians and diagnostic centers. Integrated electronic health records reduce duplication of tests, prevent medical errors and support faster and more accurate treatment decisions (Chakraborty et al., 2019). This reduces unnecessary expenses for repeated diagnosis and specialist consultation. (Bakker et al., 2025). For India's aging population in the Delhi region, these devices provide a sustainable, cost-effective pathway to long-term cardiovascular care (IIPS et al., 2020).

Level of adoption and usage of digital health technologies among elderly cardiac patients in the Delhi region

The level of adoption and use of digital health technologies among elderly cardiac patients in the Delhi region shows a pattern of gradual acceptance mixed with persistent challenges (Kundu & Kundu, 2022). Many older people have become increasingly exposed to digital platforms through teleconsultation services introduced during the COVID-19 pandemic, resulting in moderate levels of familiarity with virtual doctor visits, online appointment booking systems and digital access to diagnostic reports (Kumar & Sharma, 2021). Telemedicine is emerging as the most widely used tool, as it provides convenience, reduces hospital visits and reduces physical stress for heart patients who often struggle with mobility issues.

An important factor influencing adoption is digital competence. While some elderly patients are comfortable using the basic functions of smartphones, many experience difficulty navigating apps, understanding digital instructions, or interpreting device output (Kumar & Prakash, 2020). In contrast, economically disadvantaged patients are more dependent on personal consultations due to a lack of resources and limited digital exposure (NITI Aayog, 2020).

Despite these challenges, there is a growing willingness to explore digital health technologies among older cardiac patients, especially when encouraged by healthcare professionals (Kumar & Sharma, 2021). Cardiologists at metro hospitals in Delhi are increasingly recommending mobile-based reminders, lifestyle monitoring apps and home-based diagnostic devices, which have contributed to growing acceptance. Concerns such as fear of misuse of the technology, potential privacy issues, lack of trust, and the inability to independently troubleshoot technical problems continue to limit widespread use.(Kumar & Prakash, 2020).

The impact of digital health tools on reducing out-of-pocket expenditure related to cardiac treatment and management.

Digital health tools have started playing a transformative role in reducing cardiac and long-term care expenses among patients, especially in urban areas like Delhi, where the financial burden of cardiovascular disease remains high (Roth et al., 2020). For elderly heart patients who often must incur huge recurring expenses for consultations, diagnostic tests, medicines and travel digital technologies provide alternative pathways that significantly reduce the financial burden (Rahman et al., 2022). Telemedicine is one of the most effective tools that enable patients to replace personal follow-up with virtual consultations, reducing costs related to transport, service fees in hospitals and loss of work for carers (Redfern et al., 2022). Many patients report that routine inquiries, prescription renewals and symptom monitoring can be managed remotely, reducing unnecessary hospital visits (World Bank & WHO, 2018).

Digital diagnostic tools, such as smartphone-enabled EKG devices, wearable heart rate monitors and app-based blood pressure monitors, reduce reliance on hospital-based diagnostic services (Bakker et al., 2025). Instead of spending on frequent EKGs, BP checks or stress assessments, patients can monitor key parameters at home with a relatively small one-time investment. When abnormalities occur, digital alerts allow for timely medical intervention, preventing complications that might otherwise lead to emergency admissions one of the most expensive components of cardiac care (Nwokedi et al., 2025). In addition, digital medication reminders and apps to track adherence support consistent treatment, reducing the risk of disease recurrence or progression that can lead to increased medical expenses (Redfern et al., 2022).

Digital payment systems and online pharmacies also help to reduce OOPE. Many patients take advantage of discounted drug prices from licensed e-pharmacies compared to offline stores (Nwokedi et al., 2025). Similarly, digital platforms that offer bundled teleconsultation plans, online diagnostic packages, and subscription-based monitoring services often cost significantly less than individual service fees (Redfern et al., 2022). Insurance-linked digital portals and public health apps help patients identify eligible plans, direct them towards subsidized options and reduce unplanned expenses (World Bank & WHO, 2018).

Although the potential to reduce OOPE is large, not all patients experience the same level of savings due to variation in adoption, awareness, and technical support (Rahman et al., 2022). Nonetheless, evidence suggests that digital health tools can meaningfully reduce the financial burden by reducing travel costs, reducing clinical expenses, improving medication adherence, and

preventing costly health emergencies (Redfern et al., 2022). As digital ecosystems continue to expand in urban India, their role in reducing cardiovascular healthcare costs for the elderly population is expected to grow significantly (Roth et al., 2020).

Objectives

1. To assess the level of adoption and usage of digital health technologies among elderly cardiac patients in the Delhi region.
2. To examine the impact of digital health tools on reducing out-of-pocket expenditure related to cardiac treatment and management.
3. To analyse patient- and system-level factors influencing the effectiveness of digital health technologies in minimizing cardiac healthcare costs for the aging population.

LITERATURE REVIEW

Athavle (2024) highlights how India's digital health infrastructure particularly Co-WIN and the Ayushman Bharat Digital Mission strengthens healthcare delivery through improved digital records, interoperable platforms, and streamlined service access. The study emphasizes that these digital systems can reduce administrative costs and enhance efficiency, especially for vulnerable populations.

Bakker et al. (2025) introduce the V3+ framework, which expands existing digital health evaluation models to ensure sensor-based technologies remain user-centric, scalable, and clinically reliable. The study stresses the importance of validating digital tools for long-term health monitoring, supporting safe adoption among patients with chronic conditions.

Bhattarai et al. (2020) analyse cardiovascular disease trends in Nepal using global burden data, showing rising prevalence and mortality linked to aging populations and lifestyle factors. Their findings underscore the need for cost-effective, technology-enabled strategies for early detection and management in South Asian contexts. Chakraborty et al. (2019) explains how digital transformation driven by artificial intelligence and blockchain is reshaping healthcare systems by enhancing data security, diagnosis accuracy, and personalised care. The book demonstrates how such technologies can reduce inefficiencies and improve long-term disease management.

Gupta et al. (2022) highlights the substantial financial burden posed by cardiovascular diseases in India, showing that a large share of patients' expenditure comes from out-of-pocket payments for consultations, diagnostics, medicines, and hospitalizations. The study reinforces the need for affordable and technology-supported cardiac care to reduce economic strain on households.

Harikrishnan et al. (2024) report high one-year mortality and frequent re-admissions among cardiac patients in India across multiple centers, indicating gaps in long-term monitoring and follow-up care. The findings underscore the importance of continuous digital monitoring and early intervention to prevent costly complications.

The LASI (2020) national report documents the health status, disease burden, and care utilisation patterns among India's older population. It reveals rising rates of chronic illnesses, including cardiac conditions, and highlights challenges related to healthcare access, affordability, and multimorbidity in the elderly, making digital health solutions increasingly relevant.

Research Gap

Despite the growing use of telemedicine, wearable monitors, mobile health apps, and online pharmacies, limited evidence exists on how effectively these digital health technologies reduce out-of-pocket expenditure (OOPE) for elderly cardiac patients in India. Most studies emphasize clinical outcomes or general digital adoption but do not examine cost savings specifically for older adults, especially in urban contexts like Delhi. Existing national datasets such as LASI also lack information on the economic impact of digital tools. Moreover, it remains unclear which digital technologies offer the greatest financial benefits and how factors like digital literacy, trust, and socioeconomic status influence their cost-saving potential. Therefore, focused research is needed to understand the real contribution of digital health technologies in lowering cardiac healthcare costs among Delhi's aging population.

RESEARCH METHODOLOGY

This review study employed a systematic and structured methodology to examine the role of digital health technologies in minimizing cardiac healthcare costs for India's aging population, with a specific focus on the Delhi region. The methodology followed the PRISMA guidelines for transparent reporting of literature search, screening, and selection processes.

Search Strategy

A comprehensive search was conducted across major scholarly databases, Scopus, Web of Science, Google Scholar, and ResearchGate. The search focused on studies published to capture recent developments in digital health technologies. Keywords and Boolean combinations used included: "digital health technologies," "telemedicine," "mHealth apps," "remote cardiac monitoring," "cardiac diseases," "elderly population," "aging population India," "healthcare costs," "out-of-pocket expenditure," and "Delhi region."

Table 1. Inclusion and Exclusion Criteria.

Category	Criteria	Details
Inclusion Criteria	Focus of Study	Digital health technologies related to cardiac disease prevention, diagnosis, monitoring, or management
	Population	Adults aged 60 years and above (aging population)
	Geographic Context	Studies conducted in India or comparable developing health systems
	Outcomes Measured	Cost-related outcomes such as: • Reduction in out-of-pocket expenditure • Reduced hospitalization costs • Improved medication adherence • Higher treatment efficiency
	Type of Studies	Empirical studies, reviews, qualitative studies, mixed-method studies
Exclusion Criteria	Disease Focus	Studies focusing on non-cardiac diseases
	Technology Focus	Studies not involving digital health technologies
	Outcome Reporting	Lack measurable or descriptive cost-related outcomes
	Type of Sources	Editorials, commentaries, blogs, or non-scholarly sources

Screening Process

A total of 266 articles were initially identified. After removing duplicates, titles and abstracts were screened for relevance. Articles that did not meet the inclusion criteria were removed. Full texts of potentially relevant articles were then assessed for eligibility.

A PRISMA flow diagram developed by the author visually summarises the systematic screening and selection process. Out of 266 initially identified studies, duplicates were removed, followed by title and abstract screening, full-text evaluation, and exclusion based on predefined criteria. Finally, 18 studies met the inclusion criteria and were incorporated into the synthesis. The diagram helps illustrate the methodological transparency of the review and ensures clarity in tracking how the final evidence base was formed.

Table 2. PRISMA Flow Summary.

Stage	Description	Number of Articles (n)	Notes / Reasons
Identification	Articles identified through database searching	**266**	—
Screening	Articles screened after removing duplicates	**214**	—
Screening	Articles excluded after title and abstract screening	**150**	Not relevant, outside scope
Eligibility	Full-text articles assessed for eligibility	**64**	—
Eligibility	Full-text articles excluded	**46**	• Lack of cost analysis • Not elderly-specific • Insufficient digital-health-related data
Included	Studies included in final synthesis	**18**	Final set for systematic review

These 18 studies constituted the final evidence base for thematic and comparative analysis.

Data Extraction and Analysis

Data extraction and analysis were carried out systematically to ensure consistency and reliability across the reviewed studies. For each study included in the final synthesis, relevant information was manually extracted and organized using a structured coding sheet. The data extracted includes key dimensions such as the type of digital health technology used, including telemedicine platforms, mHealth applications, wearable cardiac monitoring devices and AI-based clinical decision-making tools. Given the heterogeneity of study design and outcome measures, a narrative synthesis was used instead of meta-analysis. The synthesis was structured around three main themes: adoption and use of digital health technologies among older adults, the effectiveness of these technologies in reducing out-of-pocket costs, and barriers and facilitators affecting their implementation. Findings from quantitative and qualitative studies were triangulated to generate comprehensive insights. As this review is based entirely on secondary data, ethical approval was not required and all studies used in the review were correctly cited to maintain academic integrity.

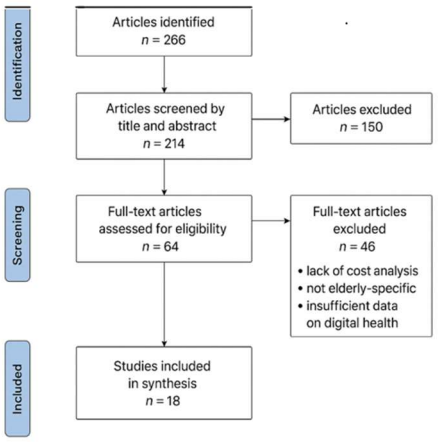

Figure 1. PRISMA flow.

CONCLUSION

The review shows that digital health technologies have significant potential to reduce cardiovascular healthcare costs for India's growing population, especially in metropolitan areas like Delhi where the economic burden of cardiovascular disease is high. Evidence from the analyzed studies shows that telemedicine, remote monitoring devices, mobile health applications, online pharmacies and digital insurance platforms collectively help reduce expenses by reducing travel costs, reducing frequent hospital visits, preventing emergency admissions through early detection, and improving medication adherence. Although adoption levels vary among older patients due to digital literacy issues, socioeconomic disparities, trust in technology, and limited technical support, the overall trajectory points toward increasing acceptance and meaningful cost-saving benefits.Although digital health interventions are not yet universally available or uniformly effective, their benefits in terms of increasing affordability, continuity of care, and self-management for older heart patients are significant.

The study concludes that digital health technologies can serve as a sustainable and cost-effective component of cardiovascular care for older adults in Delhi. Maximizing these benefits will require strengthening digital literacy initiatives, expanding affordable technology access, and improving healthcare integration.

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