Bibliometric Analysis of Advances in Mobile Health Technology Applications for Chronic Disease Management: Postprint

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Abstract

Background In recent years, research on mobile health technology in chronic disease management has developed rapidly; however, the research trends, hotspots, and frontier issues in this field remain unclear. Objective To systematically review the application and development of mobile health technology in chronic disease management, and to provide reference for future research. Methods Using the Web of Science Core Collection and PubMed as data sources, relevant literature published from 1997 to 2022 was retrieved on October 18, 2022, via CiteSpace 6.1.R3 software, with language limited to English, and conference papers, conference abstracts, online publications, editorials, letters, book chapters, news, and other types of documents excluded. An analysis of countries (regions), interdisciplinary fields, and keywords of the included literature was conducted to grasp the current status and hotspots of related research internationally. Keyword clustering analysis, keyword burst detection, and timeline view were employed to comprehensively analyze the research frontiers and trends of mobile health technology in chronic disease management. Results A total of 7,622 documents were included. The volume of publications began to show a significant growth trend in 2011, with the United States contributing the most to the number of documents, totaling 2,645 (34.70%). The journals publishing these papers were mainly concentrated in fields such as medicine, psychology, and health sciences. The top five keywords by frequency were chronic disease (711 times), nursing (695 times), management (544 times), intervention (502 times), and health (448 times). A total of 10 meaningful clusters were formed, which could be summarized into four dimensions: research tools, research theories and methods, research subjects, and research factors. Based on keyword bursts and timeline views, the hotspot issues mainly focused on telemedicine, telecare, and digital health. Conclusion International research interest in the application of mobile health technology in chronic disease management remains strong. The research field has shifted from medicine to health sciences, with the research focus being intervention studies on chronic diseases through mobile health technology and providing comprehensive remote health services for chronic diseases using digital technology. This suggests that Chinese scholars should attach importance to the application of mobile health and digital technology in chronic disease management, seek high-quality health services for Chinese chronic disease patients through intervention studies, and provide strategies and recommendations for the high-quality development of chronic disease services and management in China.

Full Text

Bibliometric Analysis of Advances in mHealth Technology Application in Chronic Disease Management

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Abstract

Background: Research on mobile health (mHealth) technology in chronic disease management has developed rapidly in recent years, yet the research trends, hotspots, and cutting-edge issues in this field remain unclear.

Objective: To systematically review the application and development of mHealth technology in chronic disease management and provide reference for future research.

Methods: Using Web of Science Core Collection and PubMed as data sources, relevant literature published from 1997 to 2022 was retrieved on October 18, 2022, limited to English-language publications. Conference papers, conference abstracts, online publications, editorials, letters, book chapters, and news articles were excluded. CiteSpace software was employed to analyze the distribution of publications by country/region, disciplinary intersections, and keywords. Keyword clustering analysis, keyword burst detection, and timeline views were used to comprehensively analyze research frontiers and trends in mHealth technology application for chronic disease management.

Results: A total of 7,622 papers were included. Publication volume showed significant growth starting in 2011, with the United States contributing the most (34.70%). Publishing journals were concentrated in medicine, psychology, and health sciences. The top five high-frequency keywords were chronic disease (711 occurrences), care (695), management (544), intervention (469), and health (412). Ten meaningful clusters were identified, categorized into four dimensions: research tools, theories and methods, research objects, and research factors. Combined with keyword burst analysis and timeline views, hotspots focused on telemedicine, telecare, and digital health.

Conclusion: International research enthusiasm for mHealth technology in chronic disease management continues unabated, with the field shifting from medicine to health sciences. The research emphasis is on intervention studies for chronic diseases through mHealth technology and using digital technology to provide integrated remote health services. Chinese scholars should prioritize the application of mHealth and digital technologies in chronic disease management, identify high-quality health services for Chinese chronic disease patients through intervention research, and provide strategies for the high-quality development of chronic disease services and management in China.

Keywords: mHealth technology; Chronic disease management; Telemedicine; Telenursing; Bibliometrics

1. Introduction

Chronic diseases are complex conditions influenced by both genetic and environmental factors. In China, chronic diseases account for 86.6% of total deaths and 70% of the total disease burden, creating substantial health and economic challenges[1-2]. Characterized by long disease courses, low control rates, high disability and mortality, and broad population impact[3], chronic diseases have become a global health threat[4]. Traditional chronic disease management models, burdened by heavy workloads and low efficiency, can no longer meet rapidly growing management needs in a fast-changing environment. mHealth technology can overcome temporal and geographic barriers[5], establishing collaborative management mechanisms among patients, families, and healthcare teams. Through efficient sharing of medical resources and business coordination[6], mHealth substantially improves chronic disease management efficiency.

Over the past two decades, with the development of information and communication technologies, increasing attention has focused on providing novel healthcare services through new technologies. Driven by health service and management demands, mHealth technology applications in chronic disease management have rapidly developed. Currently, mHealth services in developed countries such as the United States and Japan have shifted from treatment to prevention-oriented approaches, accumulating rich research experience and technical capabilities and entering a stage of refined development[7], providing more reliable and effective means for chronic disease management. China's "Healthy China" and "Internet+" strategic initiatives have similarly promoted mHealth technology application and development. However, due to a later start, challenges remain in

China's intelligent information development, including incomplete functions of national health information platforms, insufficient information resource development and utilization, and data quality issues requiring improvement. Therefore, continuously advancing mobile technology and digital health development to promote chronic disease management is particularly important.

Currently, domestic research combining mHealth and chronic disease management remains relatively limited, with even fewer bibliometric analyses in this field. This study uses CiteSpace 6.1.R3 software's big data processing and information visualization capabilities to analyze relevant research, aiming to accurately grasp the research status, hotspots, and frontiers in this field and provide reference for domestic research on mHealth applications in chronic disease management.

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2. Methods

2.1 Data Sources

This study used Web of Science Core Collection and PubMed as literature data sources. Search terms included: Telemedicine, Mobile Health, mHealth, Telehealth, eHealth, Chronic Disease, Chronic Illness, Chronic Condition, and Chronically Ill.

Web of Science search strategy: TS=((Mobile Health) OR (Telemedicine) OR (Telehealth) OR (mHealth) OR (eHealth)) AND ((Chronic Disease) OR (Chronic Illness) OR (Chronic Condition) OR (Chronically Ill))

PubMed search strategy: ((Mobile Health) OR (Telemedicine) OR (Telehealth) OR (mHealth) OR (eHealth)) AND ((Chronic Disease) OR (Chronic Illness) OR (Chronic Condition) OR (Chronically Ill))

The first relevant literature on mHealth applied to chronic disease management was published in 1997, so this study's search timeframe was set to 1997-2022. The search was conducted on October 18, 2022, limited to English-language publications, with excluded document types removed. The search yielded 4,643 relevant papers from Web of Science and 5,917 from PubMed, totaling 10,560 papers. After removing duplicates, 7,622 papers remained. The entire literature retrieval and analysis process was conducted independently by two researchers, with results compared and disagreements resolved through discussion to ensure accuracy. The literature search flow is shown in [Figure 1: see original paper].

2.2 Analysis Methods

CiteSpace software intuitively displays the information landscape of specific knowledge domains[8]. This study set the timeframe to 1997-2022 with a time slice of 1 year. Parameters were set as: selection criteria: g-index k=5; pruning: pathfinder, pruning the merged network. Node types selected were country and keyword. Country data were visualized using Scimago Graphica software to create country collaboration networks[9], reflecting the global distribution and collaboration patterns of publications. Additionally, this study used CiteSpace 6.1.R3 overlay maps for interdisciplinary analysis to understand the research landscape from a macro perspective. For keyword analysis, the likelihood ratio algorithm was used to cluster high-frequency keywords, and timeline views were created. Keyword burst detection was performed to identify emerging trends and research frontiers in mHealth technology application for chronic disease management[10].

Two metrics evaluate knowledge mapping effectiveness: the clustering module index (Q-value) and clustering silhouette index (S-value), which assess network modularity structure significance and homogeneity, respectively. A Q-value >0.30 indicates significant network modularity structure, while an S-value >0.50 generally indicates reasonable clustering[11].

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3. Results

3.1 Publication Trends and Distribution

3.1.1 Temporal Trends Publications on mHealth technology in chronic disease management began in 1997, when Friedman et al.[12] first proposed using telephone-based nursing technology to provide information and support for family caregivers of chronic disease patients to improve health outcomes. Over the past 25 years, annual publication volume has shown an overall upward trend, specifically divided into three stages: (1) 1997-2010 as the initial exploration stage, with publications increasing from 6 in 1997 to 133 in 2010; (2) 2011-2016 as the steady growth stage, increasing from 141 in 2011 to 469 in 2016 with continuous growth; and (3) 2017-2022 as the rapid development stage, with overall publication volume increasing rapidly in a short period, exceeding 1,200 papers in 2021 ([Figure 2: see original paper]).

3.1.2 Regional Distribution and Collaboration According to the distribution of the top 10 countries by publication volume, the vast majority of literature originated from North America, Oceania, and Europe. The United States published the most papers in this field with 2,645 (34.70%), followed by Australia (607, 7.96%), the United Kingdom (517, 6.78%), and Canada (492, 6.45%). [Figure 3: see original paper] shows international collaboration patterns, where line thickness between countries represents collaboration intensity and node size represents publication volume and academic influence[13]. The United States collaborates closely with Canada, Australia, China, and the United Kingdom, with most collaboration limited to North America, Europe, Southeast Asia, and Oceania.

3.1.3 Journal and Discipline Distribution Journal analysis reveals the disciplinary characteristics of publications and research fields in mHealth for chronic disease management[14]. In [Figure 4: see original paper], citing journals appear on the left and cited journals on the right, with arcs representing citation links that provide understanding of interdisciplinary relationships in the research field. The z-Scores function highlights stronger, more influential trajectories, with higher scores indicating thicker connecting lines. The figure shows that publications in medicine, healthcare, and clinical fields are influenced by health, nursing, and medicine (Z=10.24, F=23,788), psychology, education, and sociology (Z=2.22, F=5,578), and molecular, biological, and genetics fields (Z=1.84, F=4,728). Publications in psychology, education, and health fields are influenced by health, nursing, and medicine (Z=35.16, F=8,526). Among these, health, nursing, and medicine constitute crucial disciplinary knowledge bases for mHealth research in chronic disease management.

3.2 Keyword Analysis

3.2.1 Keyword Frequency and Centrality Keywords provide high-level summarization of core concepts and themes in included literature, reflecting hotspots and frontiers in the field[15]. After removing meaningless keywords and merging synonyms, 371 keywords were included. The top 30 high-frequency keywords are shown in . Results indicate that "chronic disease," "care," and "management" are prominent keywords in chronic disease mHealth research, appearing 711, 695, and 544 times, respectively. Betweenness centrality measures keyword connectivity; high centrality ($ $0.1) indicates close connections with other nodes and typically represents hotspots in the field. Comparing keyword frequency and centrality rankings reveals that "system," "chronic obstructive pulmonary disease (COPD)," "support," "risk," and "depression" show upward centrality ranking shifts.

3.2.2 Keyword Clustering Analysis To clarify research content, clustering analysis was performed on high-frequency keywords to show relationships, forming 10 meaningful clusters representing main research hotspots. Keywords with high centrality in each cluster are shown in . Clusters #0 and #9 address research tools; #1, #6, and #8 address research theories and methods; #2, #4, and #7 address research objects; and #3 and #5 address research factors. Q-value=0.81 (>0.30) and S-value=0.93 (>0.50) indicate significant network modularity structure and high homogeneity, demonstrating meaningful clustering results.

3.2.3 Keyword Burst Analysis Burst intensity and temporal distribution also reflect hotspot changes and development trends in chronic disease mHealth research[16]. Based on keyword co-occurrence mapping, strongest burst term detection was performed. The top 25 burst terms included telemedicine, system, randomized trial, and management ([Figure 5: see original paper]). Overall, keyword bursts began mainly in 2001, with the strongest bursts being telemedicine

(24.95), digital health (24.81), and telecare (16.03), representing three distinct time periods of research hotspots.

3.2.4 Timeline View Analysis The keyword clustering timeline view clearly shows start and end time points for each cluster theme[17], indicating development intervals of mHealth in chronic disease management and revealing evolutionary paths of research content. Quality of life represents a classic direction in chronic disease mHealth research, while the Unified Theory of Acceptance and Use of Technology (UTAUT2) is a newly concerned theoretical foundation in recent decade, and digital health emerges as a new development direction ([Figure 6: see original paper]).

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4. Discussion

4.1 Research Context

The growth trend starting in 2011 indicates increasing attention to mHealth in chronic disease management, attributable to the emergence of new-generation smartphones with open operating systems that increased mobile phone dependence[18]. Simultaneously, new mobile medical services were extensively developed and applied, playing important roles in patient education, disease self-management, and remote patient monitoring[19-20], sparking related research enthusiasm. Developed countries led by the United States initiated research earlier on applying mobile medical technology to improve patient health, while developing countries conducted less research and faced substantial barriers in implementing mobile medical initiatives to improve health for vulnerable populations like chronic disease patients[21].

From a disciplinary perspective, beyond the core field, research concentrates in psychology and health education. Key self-management behaviors of chronic disease patients require targeted education and support, which eHealth and mHealth have now enabled, playing important roles in improving psychological and physical health outcomes[22]. Patient health is inseparable from human education and social development, driving mHealth application and research in chronic disease management toward interdisciplinary development. Future research is expected to continue in psychological education and sociology domains, showing multidisciplinary integration trends.

4.2 Research Hotspots and Trends

4.2.1 Research Objects: Major Chronic Diseases Hotspot objects in chronic disease mHealth research include COPD, chronic kidney disease (CKD), diabetes, and cardiovascular diseases—also major causes of chronic disease patient mortality[23]. Hospital care for moderate-to-severe COPD patients incurs high medical costs and reduces quality of life. Many scholars focus on developing assistive technologies and innovative methods to help COPD patients achieve self-management. To reduce CKD patients' risk of progressing to end-stage renal disease, mHealth interventions increase access to health information, improve healthcare quality, and promote healthy behaviors[24]. Diabetes management is resource-intensive and requires time-consuming documentation by patients and care teams, while mHealth technology adds new dimensions to diabetes management and care[25], with devices and tools widely applied in diabetes prevention and management research. Cardiovascular diseases, including hypertension, coronary artery disease, and congestive heart failure[26], have dynamically quantifiable management indicators like heart rate and blood pressure, making them suitable for mHealth technology to help patients reduce disease risk[27]. While mHealth management technologies are widely applied in chronic disease management, current scholarly attention concentrates on certain disease types influenced by disease characteristics and measurability. With technological advancement, mHealth holds greater potential for patient benefits, and these diseases will likely remain key research foci.

4.2.2 Telemedicine in Chronic Disease Management Telemedicine was a prominent hotspot during the 2010-2017 steady development stage. Initially defined by the European Commission in 1993, telemedicine emphasized patients' unrestricted access to remote healthcare through telecommunications and technology. Subsequently, the American Telemedicine Association (ATA), World Health Organization (WHO), and European Health Telematics Association (EH-TEL) defined it in 1996, 1998, and 2008, respectively[28], expanding the concept from relatively narrow diagnostic and treatment services to broader health domains, including remote diagnosis, consultation and nursing, education, and medical information services[29]. Telemedicine consultation showed good feasibility for follow-up care in CKD patients[30]. Telemedicine not only provided more convenient medical services for remote-area patients, reducing their economic burden, but also improved uneven medical resource distribution, enhancing care quality and patient satisfaction. Additionally, home telehealth gained widespread recognition and application in COPD patients. However, telemedicine also faced issues of lagging technical infrastructure and limited expert resources, requiring technical support even in advanced stages, with some low- and middle-income countries lacking telemedicine system construction capabilities.

4.2.3 Telecare in Chronic Disease Management Telecare emerged as a prominent hotspot during the 2010-2017 steady development stage. Telecare applications include remote monitoring, training, guidance and consultation, and home care[31], formally proposed in 2009 and developing alongside telemedicine. Remote monitoring is widely suitable for chronic disease patients with mobility difficulties or in remote areas, enabling real-time monitoring of vital signs and glucose levels[32]. Against global aging trends, scholarly attention gradually shifted from hospital to home monitoring, improving chronic disease patients' healthcare accessibility, convenience, and experience through home monitoring systems. However, while practice has achieved some success, universally applicable practice logic and theoretical models based on China's national conditions remain to be summarized and refined.

4.2.4 Mobile Technology and Digital Health in Chronic Disease Management Mobile technology and digital health represent core foci during the 2017-2022 rapid development stage. mHealth technology applications in chronic disease management specifically include short message services (SMS), mobile applications, and wearable/portable monitoring devices[33]. SMS is considered a cost-saving method for future chronic disease health services, widely promoted in low- and middle-income countries[34]. As mobile phones and tablets became popular device types, mobile applications were extensively applied in chronic disease patients' daily health management, with their freedom, portability, and real-time data collection and analysis capabilities providing substantial benefits for patients and healthcare providers[35]. Additionally, wearable electronic devices have become standard tools for medical interventions, promoting healthy behaviors like exercise[36] and helping patients reduce risks of cardiovascular disease and diabetes.

With rapid development of digital technologies like internet, big data, and artificial intelligence, digital health applications in chronic disease management have attracted academic attention[37], especially during public health emergencies when chronic disease patients face greater self-management challenges[38]. Digital health, based on new technologies including IoT, health big data, and intelligent robotics, achieves patient self-management, mental health, and quality-of-life improvement through resource integration and application innovation.

Mobile technology and digital health hold broad prospects but face obstacles and limitations. Mobile technology interventions show individual applicability differences across environments, indicating mismatches between interventions and participant motivation[39]. Medical practice has yet to resolve safety and privacy issues, lack of industry standards, and various technical bottlenecks. Elderly chronic disease patients generally show poor participation, acceptance, and long-term adherence to mobile or digital health technologies[40], resulting in underutilization. Future research will continue focusing on mobile technology and digital health applications in chronic disease management, with personalized intervention management, digital information security, and theoretical deepening in emerging fields as important directions worthy of exploration.

4.3 Limitations

This study has several limitations. First, only including Web of Science and PubMed databases may have omitted literature from other databases, and domestic Chinese literature was not retrieved, lacking comparison between domestic and international research progress. Second, the software cannot cross-analyze languages, so the search was limited to English, excluding over 200 non-English papers. Third, the broad search scope improved sensitivity but may have reduced specificity. Future research should expand to include more domestic and international databases and non-English literature, and improve search strategies.

Author Contributions

SHI Bowen conceptualized and designed the study, analyzed data, created figures and tables, and drafted the manuscript. MA Huimin conducted literature retrieval and software installation/operation. PAN Yanzhi collected and organized data. MA He revised figures and tables, analyzed and interpreted results. YANG Chen revised the manuscript. XIONG Juyang was responsible for quality control and final approval, providing overall supervision.

Conflicts of Interest: None declared.

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Note: Figure translations are in progress. See original paper for figures.