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Featured Article

Mobile health applications for communication between caregivers of community-dwelling older adults: A scoping review

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ABSTRACT

It is unclear how mobile health (mHealth) technology can be used for monitoring and communication between caregivers with spatial constraints. This systematic scoping review identifies the characteristics, functions, facilitators, and barriers of mHealth used for communication between various types of caregivers for older adults. Guided by Joanna Briggs Institute Scoping Review Methodology, all published peer-reviewed and grey literature indexed in PubMed, EMBASE, CINAHL, Cochrane Library, and Google Scholar from January 2012 to April 2022 were reviewed. Sixteen of 854 studies met the inclusion criteria. Findings suggested mHealth was primarily used for monitoring older adults' health, educating about home care, alerting about emergencies, communicating with family members or health providers, and GPS-based location tracking. Responsibility for older adults and willingness to use facilitated usage, while old age-related challenges, illiteracy, lack of technical skills, and cell phone size and Internet connectivity-related limitations impeded it. These findings can help researchers and care providers design better mHealth solutions to provide families with real-time information on older adults.

Introduction

With the 4th Industrial Revolution and the development of medical technology, population aging is being witnessed globally.[1,2] Rapid population aging has caused the role of caregivers for older adults to expand. Moreover, smaller family sizes and increased socio-economic engagement of women have gradually transformed the care for older adults from a primarily family-centered approach to one that is more socially and community-based.[3] Hence, the avenues of older adult care have diversified to include nursing homes, nursing hospitals, group homes, and welfare housing.[3] However, many older adults have a strong attachment to their homes and communities, where they have lived for a long time and where they hope to spend the rest of their lives.[4] Therefore, the primary goal of medical welfare for older adults in many countries is aging in place (AIP), a policy that supports older adults living independently in their own homes and communities for as long as possible.[5]

With the increasing need for AIP, new roles and adaptations are required for various types of caregivers, including care service providers, care workers, family members living together, long-distance family members, relatives, and significant others, who are involved in caregiving at home as an alternative to hospitals or nursing homes.[6] The importance of communication between care workers and long-distance family members has also increased significantly.[7] Furthermore, long-distance caregiving (LDC) has become more prevalent owing to career or educational commitments, children moving away, military deployment, divorce, personal choice, and other factors.[7] However, long-distance family members often face challenges in communicating with older adults and caregivers, including care workers, due to limited opportunities for interaction.[8,9] Previous studies have shown that care workers providing direct care to older adults have negative perceptions of families who pay infrequent visits, but they may also feel uncomfortable when the family actively participates in caregiving.[8] Both the absence and involvement of family members in the caregiving process can amplify the burden on care workers and give rise to conflicts.[8-11]

Mobile health (mHealth) solutions could be an effective means to address the spatially related problems of long-distance caregivers by providing remote monitoring and supporting information sharing between caregivers. Abuelómetro, an application used in Mexican nursing homes, replaces paper-based health records with digital

Abbreviations: AIP, Aging in Place; LDC, Long-distance Caregiving; mHealth, Mobile health; JBI, Joanna Briggs Institute; PRISMA-ScR, Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for Scoping Review

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charts and allows older adults to share details about their daily lives, food intake, health conditions, injuries, medical treatments, photos, and other records with their doctors and family members.[9] Physical data, such as temperature, oxygen saturation, pulse, and respiration, are monitored in real-time. In case of abnormalities, alerts are sent to doctors, caregivers, and family members within the mHealth network to facilitate timely intervention. Moreover, family members can provide their input, communicate their requests, and actively participate in the decision-making process concerning the nursing and treatment of older adults.[9, 12]

Sharing health information between care workers and families living away is essential for providing optimal care services and promoting the health of older adults. Reviewing cases of mHealth application usage can enhance and reinforce this vital function and benefit various caregivers.

To date, several reviews have explored the use of mHealth applications for caregivers, including those focused on family caregivers[13], for informal caregivers of patients with chronic diseases,[14], and for caregivers directly involved in providing care for older adults.[15] Although these reviews have provided valuable insights into the scope and coverage of mHealth applications, they have not considered the specific context of the post-COVID era, characterized by a significant increase in technology adoption. They have also not considered factors such as access, ease of use, and the reasons behind the surge in publications. Additionally, the extent to which mHealth applications and eHealth technology, which have rapidly evolved to keep up with changing technological trends, are specifically utilized for communication among caregivers remains unclear.

In this regard, a scoping review is a suitable approach to address this knowledge gap and comprehensively explore the emerging evidence.[16] Therefore, this study aims to conduct a scoping review to identify and map available evidence on the characteristics, functions, facilitators, and barriers of mHealth applications used for communication among caregivers. The findings will not only help identify the limitations of existing applications but also provide valuable directions for future application development.

Methods

This study was conducted in accordance with the PRISMA-ScR Checklist and Joanna Briggs Institute (JBI) methodology for a scoping review.[17,18] The description of the research method followed Arksey and O'Malley's five-stage framework.[16] The last stage has been described in the results section. This study design was considered exempt from ethical review by the Institutional Review Board of X University, as the data were de-identified (IRB No. 4-2021-1677).

Stage 1. Identifying the research question

In Stage 1, we focused on determining the participants, concept, and context of the study to formulate the research question.[18] The participants were various types of caregivers responsible for providing home care or assistance to community-dwelling older adults. They included, in particular, formal caregivers such as care service providers or care workers, and informal caregivers, such as family members living together, long-distance family members, and other significant others involved in the care of older adults. However, healthcare professionals and older adults were not included.

The key concept of this review was mHealth applications that are specifically designed for communication between caregivers. It examined the specific context of care-related communication and information-sharing among caregivers in home-care settings using mHealth technologies. The focus was on digital communication that could occur between different caregiver groups, including family members living together and long-distance family members as well as between care workers and families who are presently employed. It also explored communication between care workers or families living together and health providers. However, digital communication in healthcare facilities or hospitals was not within the scope of this review.

To guide our investigation, we addressed the following research questions: (1) What are the contents and characteristics of mHealth applications used for communication among caregivers of community-dwelling older adults? (2) What are the facilitators and barriers associated with the usage of mHealth applications for digital communication among caregivers?

Stage 2. Identifying relevant studies

This scoping review considered all study design types and methods published in English and Korean from January 2012 to April 2022. The past decade has seen tremendous growth in application development. Search terms were identified and combined to address four components of research questions: (1) Mobile applications; (2) older adults; (3) home care; (4) caregivers. An initial limited search of PubMed was undertaken to identify articles on the topic. The text words contained in the titles and abstracts of relevant articles and the index terms used to describe the articles were used to develop a full search strategy for PubMed, EMBASE, CINAHL, and Cochrane Library. As a final step, search terms were placed on Google Scholar to identify any additional literature. Prior to the full literature search, keywords were selected by checking the synonymous terms related to each research topic, and a search formula was derived through a review process with a librarian. Boolean operators and truncation using AND/OR were used, and each word was combined and searched based on the characteristics of each database (Table 1).

Stage 3. Study selection

Following the search, all identified citations were collated and uploaded into EndNote 20 and duplicates were removed. Two researchers individually reviewed the title and abstract and selected 38 studies that met the inclusion criteria (from the 854 studies) through search strategies. The full text of selected citations was assessed in detail against the inclusion criteria by two independent reviewers. Any disagreements were discussed and resolved by reviewers. Twenty-two studies that did not meet the inclusion criteria were excluded. The remaining 16 studies were included in the final literature analysis. The search results and the study inclusion process was presented in a Preferred Reporting Items for Systematic

Table 1
Search terms used for secondary evidence

Category	MeSH Terms	Keywords
Category 1	Mobile applications	mobile application, mobile application* smartphone, smartphone* internet, internet* eHealth, eHealth* mHealth, mHealth* telehealth, telehealth*
Category 2	Frail elderly, Aged	older adults, older adults* elderly, elder* aged, aging
Category 3	Home nursing Home care services	home nursing home care services, home care service* home care, home care* visiting nursing community care, community care* home care nurses, home health nurs* health visitor, health visitor* visiting nurses, visiting nurs* home nursing
Category 4	Caregivers	caregiver, caregiver*, caregivers family, famil* informal caregiver, informal caregivers, informal caregiver*

Reviews and Meta-analyses extension for scoping review (PRISMA-ScR) flow diagram (Fig. 1).

Stage 4. Charting the data

Data were analyzed in Microsoft Excel using the descriptive-analytical narrative method. The characteristics of each study were entered into a chart developed by the researchers. Author, year of publication, country, research design, research method, characteristics of the older adult, application purpose, application user, application name, platform, number of study participants, and function and content of the application were the information documented. The two researchers independently assessed the selected studies and extracted information. In case of disparity in the research content, the final content was determined through discussion.

Results

Characteristics of the included studies

To investigate the two research questions, we extracted common concepts and themes from the selected 16 studies to understand the key themes of mobile applications used by caregivers of community-dwelling older adults. The number of publications has steadily increased since 2018; 2019 accounted for the highest number of publications (four). The countries that conducted the research were the United States of America, Australia, Sweden, the Netherlands, Finland, China, Brazil, Norway, and France. The United States conducted the most studies (four), followed by Australia and Sweden (two studies each). In addition, three studies were multinational (Table 2).

The study design and methodology varied. Six were qualitative studies[19-24] and five mixed-method studies.[25-29]

Five studies were on older adults living at home with no described illnesses,[19,23,24,30,31] five studies were on older adults with dementia,[20,25,27,28,32] two studies were on older adults with chronic disease,[22,33] two studies were on terminally ill patients,[21,26] one study was on older adults living in nursing homes,[29] and one study was on older adults with no more than moderate impairment.[34]

Target users of the applications

Various groups and individuals were the target users of the applications. They were designed for caregivers only,[19,20,25,28,31,32] caregivers and long-distance family members,[23,24,29] caregivers and health professionals,[21,26,27,30,33,34] and caregivers or health providers and older adults.[22] Care workers, family members living together, and significant others such as relatives were the types of caregivers. Health professionals included palliative care teams, health providers, and health institutions (Table 2).

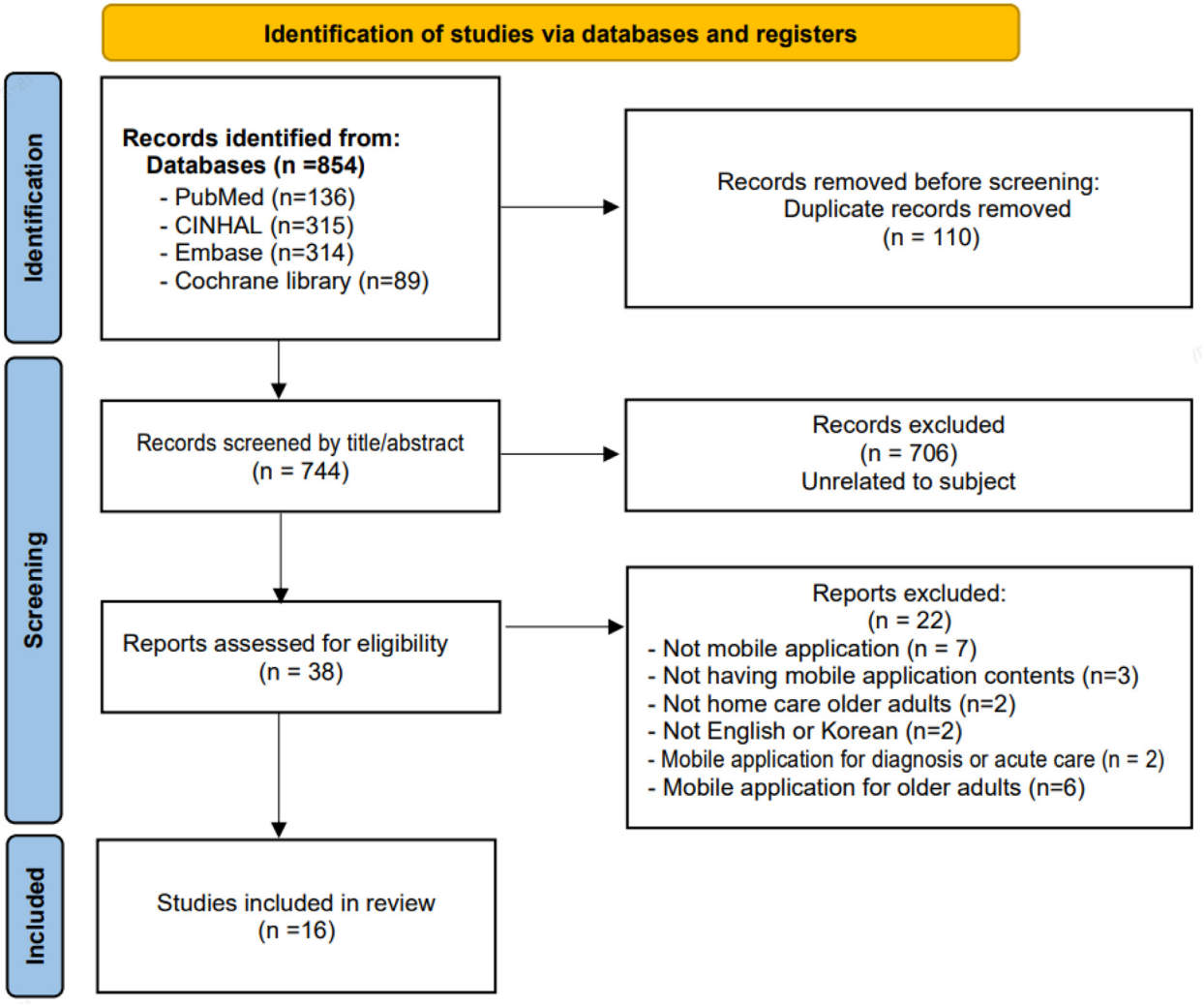

Fig. 1. Flow diagram of study selection.

Table 2
Characteristics of included studies on caregivers of community-dwelling older adults.

No	Authors	Year	Country	Design	Characteristics of older adults	Methodology	App objectives	Target users	App name	Platform	Sample size	Ref. No
1	Rathnayake et al.[25]	2021	Australia	App design study App development	Dementia	Mixed-method study	To address educational and supportive needs related to the functional disability care of family caregivers	Caregivers	Dementia Support for carers	Android	N= 177 caregivers	25
2	Harding et al.[26]	2021	India, Uganda, Zimbabwe	App design study Post-use study	Home-based palliative care patients	Mixed-method study	To enable or improve communication between caregivers and palliative care teams	Caregivers and health professional	A prototype	Android	N=149 caregivers	26
3	Mendez et al.[32]	2021	USA	App design study Need assessment	Dementia	Cross-sectional, correlational study	To support self-care for caregivers	Caregivers	N/A	N/A	N=117 caregivers	32
4	Bousquet et al.[34]	2019	France	Post-use study	Older adults living in home	Longitudinal observational pilot study	To monitor any deterioration in the health status of older adults	Caregivers and health professional	ADMR	N/A	N=106 caregivers	34
5	Karlsen et al.[19]	2019	Norway	Post-use study	Older adults living in home	Qualitative study	To provide a solution to in-home care services for aging in place	Caregivers	N/A	N/A	N=25 participants (N=18 Older adults, N=7 caregivers)	19
6	Stutze et al.[27]	2019	Brazil	App design study App development Post-use study	Dementia	Mixed-method study	To improve communication between caregivers and health professional	Caregivers and health professional	SMAI	Android	N=140 participants (N=131 caregivers, N=9 Health team)	27
7	Ruggiano et al.[20]	2019	USA	Post-use study (pilot)	Dementia	Qualitative study	To provide for the common educational and support needs of AD/RD caregivers	Caregivers	Care IT	Android	N = 36 caregivers	20
8	Zhou et al.[30]	2018	China	App design study Post-use study	Older adults living in home	Development study	To use a remote healthcare system based on a moving robot	Caregivers and health professional	N/A	N/A	N=4 older adults	30
9	Phongtankuel et al.[21]	2018	USA	App design study Need assessment	Home-based palliative care patients	Qualitative study	To support caregivers in communication, information, and education	Caregivers and health professional	N/A	N/A	N=80 caregivers	21
10	Göransson et al.[22]	2018	Sweden	App design study Post-use study	Chronic disease	Qualitative study	To assess health concerns and reports	Older adults, caregivers, and health providers	Interaktor	IOS /Android	N=29 participants (N=17 older people, N=12 caregivers)	22
11	Ekström et al.[28]	2017	Sweden	App design study Post-use study	Dementia	Mixed-method study	To support communication for people with dementia	Caregivers and older adults	GoTalk	iOS /Android	N=2 participants (N=old people, N=1 husband)	28
12	Tao et al.[31]	2016	USA, China	App design study	Older adults living in home	A multi-part study	To support caregiving	Caregivers	A prototype	N/A	N=100 caregivers	31
13	Warpenius et al.[29]	2015	Finland	App design study Need assessment	Living in private nursing homes	Mixed-method study Online surveys and face to face interviews	To enable family members to keep track of older adults	Caregivers and long-distance family members	SIMSALA	N/A	N=53 participants (N=32 relatives, N=3 nurses, N=18 nursing students)	29
14	Uhr et al.[23]	2015	Netherlands, USA	Post-use study Need assessment	Older adults living in home	Qualitative study	To update on the overall well-being of older adults	Caregivers and long-distance family members	RelaxedCare	AAL middleware platform HOMER	N=25 participants (N=11 informal carers, N=10 the youths, N=10 assisted persons)	23

(*continued on next page*)

Table 2 (*Continued*)

No	Authors	Year	Country	Design	Characteristics of older adults	Methodology	App objectives	Target users	App name	Platform	Sample size	Ref. No
15	Williamson et al.[24]	2014	USA	App design study Need assessment	Older adults living in home	Qualitative study	To provide remote monitoring of older adults	Caregivers and long-distance family members	A prototype	N/A	N=10 caregivers	24
16	Wade et al.[33]	2012	Australia	Post-use study	Chronic disease	Quasi-randomized controlled trial	To provide health monitoring	Caregivers and health professionals	Tunstall	N/A	N=24 caregivers N=43 older adults	33

ADMR, Aide a domicile en milieu rural (France's leading personal care non-profit network); AD/RD, Alzheimer's disease and related dementia; SIMSALA, seniors' integrated multi-sensor health and safety monitoring; AAL, Ambient Assisted Living

Features of the applications

The features of applications in the 16 studies were categorized into four types: monitoring, education, communication, and tracking (Table 3 & Table 4).

Monitoring

A health monitoring function was included in 12 of the 16 studies (75%).[19-24,26,27,29-31,33] This feature records, updates, and displays the health condition of older adults in real-time for application users. The monitored health conditions included physical states (blood pressure, blood glucose, basic information, diet, body temperature, respiration, dietary problems, cough, oxygenation, and ECG), activity and movements (wandering alarm, fall detection, patient location, video monitoring), loneliness, mood, pain, emotional state, appetite, and sleep quality.[29] Some applications monitored the caregivers' stress levels.[27] Digital devices, such as heart rate sensors,[23,30,33] posture detection systems,[24,30] systems that track pain, nausea, and anxiety levels of terminally ill patients,[21] and cameras that check the status of patients with cognitive impairments,[19] were used to detect and report health conditions in real-time. The monitored data were color-coded and displayed in the application,[20,26] and translated into graphs for users to detect changes over time.[22,24]

Environment-monitoring functions were included in 3 out of 16 studies (18.8%).[19,23,29] The feature monitored temperature,[29] fire incidents,[19,29] home invasions,[19] and fall incidents[19] in the subjects' residences. Smoke detectors installed in residences monitored fire hazards,[19] door sensors monitored break-ins and wandering during the night, and light sensors monitored the movements of older adults to provide safe paths in the house.[19]

Education

Out of the 16 studies examined, 31.3% (5 studies) introduced educational functions for caregivers to enhance their knowledge and skills in health information and management.[20,21,24,25,31] These functions focus on providing caregivers with information and tools to manage the health and care of older adults. The educational content in these five studies included medication management for older adults at home,[20,21,24,25,31] care strategies for older adults with dementia, effective communication methods while caring for older adults with dementia, management of drugs and non-drugs, pain management, common problems and solutions during care,[25] care for terminally ill patients,[21] and medical information required to provide nursing services.[31] Education was imparted through online health resources,[24,25] app-based explanation guides and tutorial videos,[21] and links to domestic and international dementia associations.[25]

Furthermore, 3 out of 16 studies (18.8%) reported on caregiver self-education.[20,25,32] Caregiver self-education focuses on educating and supporting caregivers to help them manage their own well-being and enhance their caregiving skills. The educational content encompasses aspects such as well-being, exercise, meditation, and music appreciation programs for stress and anxiety management,[25] as well as education on self-management of chronic diseases or self-assessment for depression and care burden.[20, 32]

Communication

Information-sharing functions were included in 10 out of 16 studies (62.5%).[19-24,26,27,29,30] These functions involve sharing information on the condition of older adults through photos,[21,24,27] videos,[21] specific platforms,[20] state summary metrics,[24] report tables,[26] graphs,[22] color codes,[22,26] and color tubes.[23] The information included

Table 3
Findings

No	Authors	Monitoring		Education		Communication One-way				Communication Two-way	Tracking
		Health condition	Environment	Home care	Caregivers	Information sharing	Alarm	Alert	Calendaring		
1	Rathnayake et al.[25]			√	√		√		√		
2	Harding et al.[26]	√				√					
3	K. J. W. Mendez et al.[32]				√						
4	J. Bousquet et al.[34]							√			
5	C. Karlsen et al.[19]	√	√			√	√	√	√		√
6	M. C. Stutze et al.[27]	√				√	√	√		√	√
7	N. Ruggiano et al.[20]	√		√	√	√		√			
8	B. Zhou et al.[30]	√				√	√	√		√	
9	V. Phongtankuel et al.[21]	√		√		√			√	√	
10	C. Göransson et al.[22]	√				√	√	√		√	
11	A. Ekström et al.[28]									√	
12	H. Tao et al.[31]	√		√						√	
13	E. Warpenius et al.[29]	√	√			√	√	√		√	√
14	M. B. Uhr et al.[23]	√	√			√	√	√			
15	S. S. Williamson et al.[24]	√		√		√		√	√	√	
16	R. Wade et al.[33]	√					√				
Total (%)		12 (19)	3 (5)	5 (8)	3 (3)	10 (16)	8 (12)	9 (14)	4 (6)	8 (12)	3(5)

symptoms and health problems of older adults,[21,22,26] vital signs and behavior patterns,[23] cognitive health, exercise, sleep, medical records, overall health status,[24] visit schedules,[29] checklists for all actions taken during the visit,[21] changes in treatment plans,[21] blood pressure, blood glucose, temperature, pain,[27] and meal, medication, pain, emotion, and activity level.[29]

The alarm function was included in 8 out of 16 studies (50%).[19,22,23,25,27,29,30,33] This function notifies or reminds caregivers about important events. There were reminder alarms for previously recorded specific events, tasks,[25] snooze alarms that reset the alarm according to a set time interval (minutes, hours, days, weeks, months),[25] medication alarms,[19,25,27] meal alarms,[19] daily schedule alarms,[19,25,27] alarms that notify users to write a report at a specific time every day,[27] and alarms about the older adult's condition.[22,23,29,30,33]

The alert function was included in 9 out of 16 studies (56.3%).[19,20,22-24,27,29,30,34] This function signals or warns of danger during an emergency. The most common alarm was for falls.[19,29,30] Other alerts were alarms sent when health condition deteriorated,[19,22] when the VAS score dropped by more than 20% for two consecutive days, or when VAS was 0 or 100.[34] Furthermore, they included smoke detector alarms,[19,29] door sensor alarms in case of break-ins,[19] reminder alarms for older adults who did not manage their health properly,[24] and alarms rung by older adults when they required assistance.[19,27]

Calendaring functions were included in 4 out of 16 studies (25%).[19,21,24,25] Monthly calendar features were used to set schedules, events, and anniversaries, and 24-hour daily planner features were used to schedule daily activities and remind caregivers of their tasks.[25] In addition, one application had features that managed call schedules with family members, home visit schedules of caregivers, hospital visit schedules of older adults, and home visit schedules of medical staff.[21]

One-way, two-way, and bi-directional communication was reported in 8 out of 16 studies (50%).[21,22,24,27-31] These functions provided communication through direct interactions between the caregivers. Two-way communication provided included text messages,[21,22,24,27,29] video calls,[21,24,28,30] phone calls,[28,30] chatting systems,[29] and emails.[24] Text messages were sent between care workers and health professionals on a conversation-style display,[27] text messages were sent by older adults to caregivers in case of health concerns,[22] phone and video calls were sent through robots,[30]

Table 4
Meaning of contents within studies

Contents			Meaning/
Monitoring	*Health condition*		The real-time situation monitoring via camera or sensor
			Health condition caregiver's stress level or AD/RD symptom
			Tracking personal health records
	Environment		Residential environment monitoring (e.g., Room temperature, fire with smoke detector)
Education	*Health Information and management*		Health information about home care (e.g., medication, pain management)
			Management of daily living activities
			Care for dementia- or illness-related symptom
	Caregiver self-education		Stress management (e.g., exercise, meditation, and music)
			Supporting and managing the health and well-being of caregivers
Communication	One-way	*Information sharing*	Information sharing related to older adult (e.g., photo, short video, chart)
		Alarm	Reminder alarm (e.g., meals, medication and special events)
			Snooze function (e.g., minute, hour, day, week, or month)
		Alert	Emergency situation alert (e.g., fire, escape, fall)
		Calendaring	Scheduling appointments date and events (e.g., home visits, phone calls)
			Caregiver-to-family schedule sharing and date reminder
	Two-way		Bi-directional communication with caregivers (e.g., text message, phone call, video call, chatting system)
Tracking			GPS location tracking
			Location information sent automatically

video call platforms, such as Skype, were used for long-distance caregivers,[29] and photos, videos, and audio in in-app communication books were also used for communication.[28] Chatting systems and phone calls required immediate and synchronous communication; however, asynchronous communication, such as text messages and emails, allowed caregivers to communicate without interruption in their work.[24]

Tracking

The tracking function was included in the applications of 3 out of 16 documents (18.8%).[19,27,29] This function tracks and locates older adults using GPS-based location tracking. Information on the location of older adults was automatically transmitted to the app,[27] and an alarm was available for older adults with cognitive and gait disorders when they deviated from their location, fell, or needed assistance.[19] The GPS tracking function was considered useful because older adults could freely walk outdoors.[29] However, the location tracking function was found to be limited in one study.[19] Although this function was introduced to collect data on older adults' movement patterns, the location did not always indicate their position, as the older adults sometimes traveled without the device or caregivers took the device without accompanying the older adult.[19]

Feasibility

Facilitators

Several factors facilitated the usage of mHealth applications among caregivers in this study. These included a high level of education, having the responsibility for older adults, perceiving the app as useful,[32] ease of use,[20] the need for timely information, and willingness to use the application.[25] Additionally, the design of the applications played a significant role in promoting usage: usage patterns, device preferences, data-sharing preferences considering the sensitive nature of the data, presentation of longitudinal tracking data, and the use of caregiving terminology.[24] The user-centered design approach, which involved caregivers in the conception, design, and verification of the application, contributed to the usefulness and ease of use of the applications, thus promoting their adoption by a wider user base.[32]

Barriers

Barriers to engagement, use, and acceptance of applications included usability concerns,[21] complexity concerns,[31] and increased burden of care on the caregiver.[33] All users desired simplicity and ease of use, and caregivers with less experience were more concerned than caregivers with more experience about the complexity of the app.[31] Excessive and overly detailed information on applications incited more concern among family members and increased the workload of care workers.[29] Therefore, the data were proposed to be more personalized and simplified.[29]

Other barriers to caregiver application use included old age,[21,25] illiteracy,[26] technical skills required for app usage, cost of smartphones, size of cell phones,[25] Internet connectivity,[26] and security and privacy.[19,21,29] Many users were concerned about the application's management of personal health data, and mobile monitoring raised ethical and social questions.[29] To increase receptivity and universal adoption of applications, biometric authentication was presented as a solution to ensure safe access to data.[29] Further research was proposed for an app design that addressed security and usability concerns.[21] Moreover, the electronic health record system in caregiver applications was not linked to other established health record systems in other institutions, increasing the burden on caregivers.[20]

Discussion

This study aimed to conduct a scoping review to identify and map available evidence on the characteristics, functions, facilitators, and barriers of mHealth applications used for communication among caregivers. The main findings demonstrated that caregiver applications were primarily used to monitor health conditions, educate caregivers on home care, get alerts, communicate (two-way), and perform GPS-based older adults' tracking.

In this study, caregiver mHealth applications were divided into two categories according to their purpose. Applications for caregivers aimed to provide educational content to manage stress and health and improve care competency.[25,32] With these applications, caregivers were both the users and beneficiaries, as they enjoyed features such as health improvement and stress reduction. Second, applications for older adults aimed to monitor health conditions and share health and activity data with family members and health professionals.[19-24,26-31,33,34] With these applications, caregivers or care workers produced information based on their knowledge of older adults' health and activities, input information into the app, and utilized information.

In this review, 3 out of 16 studies clearly defined specific communication between remote family members and caregivers.[23,24,29] Most applications were developed for official projects of medical and healthcare institutions where older adults received healthcare. The information entered by caregivers was meant for communication and information sharing between medical staff; therefore, applications for communication or interactions between family members and caregivers were lacking. No data were found on the use of communication in information sharing and its effect on interventions. The results of the study indicated that while family members offered various forms of support to older adults, such as physical, economic, and social assistance, the sharing of care-related information from primary caregivers was not sufficient.[35,36]

Family members seek to be with older adults, even when they are far away. Therefore, they wish to communicate with caregivers or receive real-time information about older adults. Aging in place (AIP) was proposed as the direction and objective of health policies, as older adults generally prefer to stay in their own homes and communities as they age. However, health problems among older adults are the main obstacles to the enablement of AIP.[5] Therefore, older adults with health problems employ various health aid services, such as in-home support by caregivers. Communication between caregivers and family members living apart regarding care for older adults is important. Therefore, to fulfill the family's right to know and provide stable care for older adults, it is necessary to develop tools and devices that can overcome the spatial limitations of long-distance families and share information and records about older adults.

Furthermore, the literature highlighted various facilitators of and barriers to the use of mobile applications during caregiving for older adults. Care workers who cared for older adults were mostly middle-aged and old.[20,25,31,32] Thus, when new ICT was developed and implemented for the care of older adults, there were limitations in accessibility and convenience[20,25,32] and differences in app utilization based on caregivers' approaches to complex software and new technology.[20,25,32] Despite the apparent positive effects of mHealth, there were barriers to technology adoption related to the lack of a composite set of knowledge and skills among caregivers regarding the use of mHealth. These results were consistent with that of previous studies indicating that older adults' utilization of ICT was directly related to their attitudes toward accepting new technologies[37]; therefore, strategies to lower the resistance of older adults toward accepting new ICT technologies need to be developed. Gerontological design, that is, ICT design reflecting the physical and social characteristics of older adults, should be employed for smooth digital

communication between care workers and families.[38] Furthermore, a high level of education, accountability and responsibility regarding care for older adults, and the usefulness of the application facilitated the use of mobile applications.[20,25,32] These findings can be used to direct future mobile application development and education for usability enhancement.

Limitations

This study has several limitations. First, we did not conduct quality assessments to exclude articles. Results from studies using a variety of study designs and qualitative studies were included in the findings. Second, although mobile applications constantly advance and evolve, this review only included studies published within a 10-year period; therefore, interpretation of the study findings requires caution. Third, this scoping review included a wide range of applications with different purposes, functions, and uses, and it did not differentiate between countries, regions, and the health status of older adults. Therefore, it may not be generalizable. Fourth, grey literature on the most current trends in the field may not have been included in the review.

Conclusion

This study showed that mHealth applications for caregivers were primarily used to monitor health conditions, educate caregivers on home care, get alerts, communicate with various types of caregivers or health providers, and perform GPS-based tracking of older adults; they were not primarily focused on digital communication between long-distance family members and caregivers. Various facilitators of and barriers to use applications during caregiving were also identified. Therefore, new communication methods, which can satisfy both the family's needs to get real-time information on older adults and the caregivers' easy access to digital devices, need to be fostered and implemented in home-care settings. Further research on continual mHealth use can help improve mHealth solutions and contribute to the advancement of mHealth design.

Ethics approval and consent to participate

This review was approved by an author's institutional review board for redemption (IRB No. 4-2021-1677)

Authors' contributions

SP was responsible for data curation, formal analysis, and writing the original draft. SK was responsible for formal analysis, investigation, methodology, writing the review, and editing. TL was responsible for the conceptualization and review and revising the original draft.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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