mHealth Interventions to Support Caregivers of Older Adults: Equity-Focused Systematic Review

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Abstract

Background: Informal caregivers, hereafter referred to as caregivers, provide support to older adults so that they can age safely at home. The decision to become a caregiver can be influenced by individual factors, such as personal choice, or societal factors such as social determinants of health, including household income, employment status, and culture-specific gender roles. Over time, caregivers’ health can be negatively affected by their caregiving roles. Although programs exist to support caregivers, the availability and appropriateness of services do not match caregivers’ expressed needs. Research suggests that supportive interventions offered through mobile health (mHealth) technologies have the potential to increase caregivers’ access to supportive services. However, a knowledge gap remains regarding the extent to which social determinants of health are considered in the design, implementation, and evaluation of mHealth interventions intended to support the caregivers of older adults.

Objective: This study aimed to conduct a systematic review to determine how health equity is considered in the design, implementation, and evaluation of mHealth interventions for caregivers of older adults using Cochrane Equity’s PROGRESS-Plus (place of residence, race, ethnicity, culture, language, occupation, gender, religion, education, social capital, socioeconomic status–plus age, disability, and sexual orientation) framework and synthesize evidence of the impacts of the identified caregiver-focused mHealth interventions.

Methods: A systematic review was conducted using 5 databases. Articles published between January 2010 and June 2021 were included if they evaluated or explored the impact of mHealth interventions on the health and well-being of informal caregivers of older adults. mHealth interventions were defined as supportive services, for example, education, that caregivers of older adults accessed via mobile or wireless devices.

Results: In total, 28 articles met the inclusion criteria and were included in the review. The interventions evaluated sought to connect caregivers with services, facilitate caregiving, and promote caregivers’ health and well-being. The PROGRESS-Plus framework factors were mainly considered in the results, discussion, and limitations sections of the included studies. Some PROGRESS-Plus factors such as sexual orientation, religion, and occupation, received little to no consideration across any phase of the intervention design, implementation, or evaluation. Overall, the findings of this review suggest that mHealth interventions were positively received by study participants. Such interventions have the potential to reduce caregiver burden and positively affect caregivers’ physical and mental health while supporting them as caregivers. The study findings highlight the importance of making support available to help facilitate caregivers’ use of mHealth interventions, as well as in the use of appropriate language and text.

Conclusions: The successful uptake and spread of mHealth interventions to support caregivers of older adults will depend on creating opportunities for the inclusive involvement of a broad range of stakeholders at all stages of design, implementation, and evaluation.
Introduction

Background

Globally, it is estimated that 101 million older adults require care from a friend or family caregiver (informal caregiver; hereafter referred to as caregiver), with women providing most of the support [1]. The support provided by these informal caregivers is often crucial for enabling older adults to safely remain in their home environment [2-4]. Caregiving support, such as assistance with activities of daily living, attending appointments, and health management, is associated with positive outcomes for both caregivers [5,6] and care recipients [7]. Although caregivers often willingly engage in caring, their role can negatively affect their psychological well-being, particularly when care is provided over a prolonged period [8-10].

The Social Determinants of Health and Inequities Among Caregivers

The social determinants of health can influence entry into the caregiving role and the subsequent experience of being a caregiver. For example, factors such as being a woman, lower educational attainment, and living in a rural setting can bias caregiving toward individuals who may perceive that they have little agency in their choice to become a caregiver [11]. Furthermore, a greater intensity of caregiving has been identified among caregivers who are female, people of color, and of lower socioeconomic status [12]. These inequities highlight the need for interventions with both scope and accessibility to support caregivers with varied demographic characteristics.

Although some programs and community initiatives are available to support caregivers, the literature suggests that caregivers struggle to access these supportive services [13-15]. Challenges in system navigation, accessing support, geographic location, and scheduling factors can impede the successful use of services [16,17]. Recent research indicates that supportive services provided or augmented through mobile health (mHealth) technologies have the potential to make services more accessible to caregivers [18-20].

mHealth Interventions as a Potential Solution for Caregiver Support

The term mobile health (mHealth) was first coined in 2003 in response to the rapid development and expansion of mobile communication technologies being used within the health care industry [21]. The World Health Organization defines mHealth as a “medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices” [22]. The use of health information technology (computer, internet, and email) to access health records or locate health information on the web has become commonplace among caregivers as a means of informing their caregiving role [23]. Research suggests that mobile apps have the potential to have a greater positive impact on caregivers by providing support, communication, and facilitation of care, thereby reducing the burden and positively affecting caregiver health outcomes [24]. However, to the best of our knowledge, a systematic review of the impact of mHealth support on caregivers of older adults does not currently exist. Furthermore, to date, reviews on standard caregiver interventions suggest that limited work has been conducted to determine the suitability of these interventions for caregivers from backgrounds representing diverse social determinants of health characteristics [25]. Individual characteristics, such as sociodemographic characteristics and the ability to engage with technology, should be considered in the design of mHealth interventions [26].

Therefore, the objectives of this systematic review were to (1) determine how health equity is considered in the design, implementation, and evaluation of mHealth interventions aimed at caregivers of older adults using the Cochrane Equity PROGRESS-Plus (place of residence, race, occupation, gender, religion, education, social capital, socioeconomic status–plus age, disability, and sexual orientation) framework [27] and (2) synthesize the evidence on the impacts of caregiver-focused mHealth interventions, subsequently discussed through a health equity lens.

Methods

A systematic review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement guidelines [28]. The protocol for this systematic review was registered on PROSPERO (International Prospective Register of Systematic Reviews; CRD42021239584) and is available for electronic access [29].

Research Questions

The research questions guiding this systematic review were as follows:

- To what extent is health and social equity considered in the design, implementation, and evaluation of mHealth interventions for caregivers of older adults?
- What are the impacts of the examined mHealth interventions on caregivers of older adults based on the following outcomes: caregiver mental and physical health, caregivers’ ability to provide care, usability or feasibility of the mHealth intervention for caregivers, and caregivers’ experiences and perspectives of engaging in an mHealth intervention intended to support them?

Eligibility Criteria

Eligible articles were available in full text in the English language and were published from 2010 onward to reflect the recent surge in mHealth interventions, concurrent with the rapid increase in mobile device ownership within the past decade [30,31]. This review included both quantitative (experimental,
quasi-experimental, and observational studies with or without control or comparison groups) and qualitative study designs, which evaluated or explored the impacts of mHealth interventions aimed at improving the health of, or providing support to, informal caregivers of older adults. Mixed methods studies were also included. mHealth interventions were defined as those that the caregivers of older adults accessed via mobile or wireless devices (including mobile phones, tablets, handheld computers, and PDAs). Interventions not accessed by mobile or wireless devices (eg, interventions applied or accessed by landline telephone as opposed to mobile phone) were excluded, as were mHealth interventions that targeted the recipient of care only or only assessed outcomes focused on the recipient of care. Studies that exclusively included formal caregivers of older adults (eg, nurses and personal support workers) or caregivers of individuals who were not identified as older adults (eg, children, adolescents, young and middle-aged adults, or adults aged <65 years) were also excluded.

Eligible studies were also required to report at least one caregiver-specific outcome or finding, including those relating to (1) caregiver mental and physical health, (2) caregivers’ ability to provide care, (3) usability or feasibility of the mHealth intervention by caregivers, and (4) caregivers’ experiences and perspectives of engaging in mHealth interventions intended to support them. Research protocols, dissertations, reviews, commentaries, and abstracts were also excluded.

Search Strategy and Study Selection

A systematic search was conducted on five databases: PubMed, PsycINFO (ProQuest), CINAHL, Scopus, and Cochrane Library. An academic librarian was consulted during database search strategy development. Database searches combined a comprehensive suite of similar and related terms for the key domains of caregivers, older adults, and mHealth interventions. Detailed search strategies for each database are provided in Multimedia Appendix 1. The search results were limited by the year of publication from 2010 to February 2021, when the search was initially conducted. The search strategy was repeated in June 2021 to capture newly published articles. Ancestry searches were also conducted using the reference lists of eligible studies, as well as related reviews [19,32-34], to search for additional potential articles for inclusion.

Eligible studies identified from the database and ancestry searches were independently assessed by a group of 4 reviewers (AG, MN, RS, and JT). Each document was reviewed by 2 reviewers (AG, MN, RS, or JT) based on the title and abstract. The full texts of relevant studies were then obtained, and 2 reviewers (AG, MN, RS, or JT) independently examined the full texts of the selected studies to determine the final included articles in accordance with the eligibility criteria outlined previously. Covidence systematic review software (Veritas Health Innovation) was used to organize the search results and facilitate communication between the reviewers. Disagreements were resolved by consensus. In cases where consensus could not be reached, a third reviewer resolved the disagreement. The search strategy yielded an initial 1629 articles for screening of titles and abstracts. On the basis of the initial screening, the full texts of the 3.31% (54/1629) of articles were assessed. Of the 54 articles, 26 (48%) were subsequently excluded after a full-text review. The literature search and study selection processes are shown in Figure 1. A total of 28 articles met the inclusion criteria and were included in the review.
**Data Extraction**

The data were extracted using reviewer-designed data extraction forms in Covidence. A total of 2 reviewers independently performed the data extraction. Disagreements were resolved by consensus. In cases where consensus could not be achieved, a third reviewer was consulted.

Data extracted from full-text articles included (1) country of investigation; (2) study design and methods; (3) participant recruitment, demographics, and baseline characteristics; (4) description of the mHealth intervention; and (5) caregiver-specific outcomes or findings. In addition, the review team identified which (if any) social determinants of health and factors contributing to health inequities were addressed by study investigators, as described by the PROGRESS-Plus framework [27,35].

PROGRESS-Plus is a framework developed with evidence from working groups from the Campbell and Cochrane Collaborations, which can be applied to determine whether an equity lens has been used throughout the stages of study design, implementation, and reporting of research [27]. The framework includes the following equity factors: place of residence, race, ethnicity, language, culture, occupation (eg, full-time employment or retirement), gender or sex, religion, education, socioeconomic status, and social capital, as well as age, disability, sexual orientation, features of relationships, and time-dependent relationships (Plus factors) [27]. The manner in which investigators addressed these factors within the intervention itself and the study of the intervention was considered in their report of these factors within the following sections: (1) mHealth intervention design, (2) study participant recruitment, (3) study results or findings, and (4) discussion or limitations of the investigation.

**Risk of Bias Assessment**

Risk of bias (quality) assessments were performed for each study using standardized critical appraisal tools from the Joanna Briggs Institute Manual for Evidence Synthesis [36]. The Joanna Briggs Institute provides distinct critical appraisal checklists for experimental, quasi-experimental, observational, and qualitative study design. One of the reviewers performed the risk of bias assessments for each study, which was then checked by a second reviewer. Disagreements were resolved by discussion and consensus. No studies were excluded from the review based on quality assessments to achieve a comprehensive understanding of the quality of the available literature exploring the impacts of mHealth interventions for caregivers of older adults. The findings of the quality assessments and the limitations of the included articles are summarized in the results, and the summary scores of the quality assessments are presented in the Results section.

**Data Synthesis**

A narrative synthesis of findings was pursued because of the range of included mHealth interventions, caregiver characteristics, and caregiver-related outcome measures, as well as the inclusion of both quantitative and qualitative study designs. The narrative synthesis was organized under the following categories: (1) study characteristics; (2) mHealth intervention characteristics; (3) consideration of social determinants and factors contributing to health inequities in...
mHealth intervention design, participant recruitment, study results or findings, and discussion or limitations; (4) quantitative caregiver-related outcomes; and (5) qualitative caregiver-related findings.

**Results**

A total of 28 articles were included in this review. A summary of the included articles is presented in Multimedia Appendix 2 [37-62].

**Characteristics of Included Studies**

Among the 28 included studies, 14 (50%) were quantitative [37-48,63,64], 7 (25%) were qualitative [49-55], and 7 (25%) used mixed methods [56-62]. Studies were most frequently conducted in the United States [38,41,45-48,50,53,58,60], the Netherlands [37,55,57,59], the United Kingdom [54,62], and Australia [52,56]. Most studies targeted nonspecific informal caregivers of older adults; however, 25% (7/28) targeted family or spousal caregivers specifically [38,44,51,52,54,60,64]. Approximately 7% (2/28) of studies targeted caregivers who reported being isolated [56] or experiencing caregiving strain [38]. Caregivers most commonly provided care to older adults with dementia or other forms of cognitive impairment [37-39,41-44,46,47,50-56,58-60,62,64]. Other studies recruited caregivers who provided care to older adults with urinary incontinence [63], older veterans who were medically complex [45], and older adults with functional loss or struggling to remain independent at home [49,57,61].

**Risk of Bias Within Included Studies**

The full risk of bias assessments for the 28 included studies are presented in Multimedia Appendix 3 [37-62]. The potential for bias within the 11% (3/28) included randomized controlled trials [37,43,46] most commonly stemmed from a lack of blinding of participants and outcome assessors. Potential sources of bias within other quantitative studies include a lack of control groups [60,62,63] and limited consideration of potential confounders [41,56]. Most of the included quantitative studies recruited small convenience samples of caregivers or caregiver–care recipient dyads; for example, recruiting from single clinics [38,39] or from attendees of an Alzheimer’s Association chapter event [50]. Included qualitative studies were most often limited by a lack of clear alignment between philosophical underpinnings, methodology, and research questions or objectives [49-53,55-58,60,62]. Although most studies provided sufficient information to demonstrate a logical flow from the analysis and interpretation of data to the overall conclusions, few studies addressed the potential influence of the researcher on the research (eg, positionality, trustworthiness, and rigor) [54,62]. In addition, only 7% (2/28) of qualitative studies provided information on the location of the researcher’s theoretical approach [53,54]. Although other studies may also have used a theoretical lens or framework to guide their intervention and analysis, they did not report this information.

**mHealth Intervention Characteristics**

The included studies’ interventions were web-based or non–web-based applications, interventions, or videoconferencing software, which were delivered via mobile phones, tablets, and handheld computers. The intervention details, including intervention description, hardware, stakeholder input, and comparison groups, are outlined in Table 1.

The aims of these interventions fell under three interrelated categories: making connections, facilitating caregiving, and promoting caregiver health and well-being (Figure 2). The included mHealth interventions facilitated various linkages and connections between caregivers and supportive services, such as (1) connecting the care recipient’s circle of care, including caregivers and health professionals [44,45,48,51,53,55,57,58,61]; (2) connecting the caregiver to existing social support or facilitating new connections to peer support [40,43,46,56,59]; and (3) connecting the caregiver to services and resources for both themselves and the recipient of care [37,43,47,50,51,53,58].
Table 1. Details of mobile health interventions of included studies.

| Study | Intervention description | Hardware provided | Stakeholder input described | Comparator intervention (as applicable) | Study quality appraisal scores<sup>a</sup> |
|-------|--------------------------|-------------------|-----------------------------|------------------------------------------|------------------------------------------|
| **Quantitative studies—randomized controlled trials** | | | | | |
| Beentjes et al [37] | FindMyApps, a web-based selection tool and learning training program to help caregivers find user-friendly apps | Yes; tablet | No | Caregiver controls received a tablet but no FindMyApps training or access; received a list of links to websites with apps for people with dementia or mild cognitive impairment | 8/13 |
| Hastings et al [45] | Video-enhanced care management: a 14-week care management intervention that included 3 monthly video calls with nurses via a secure internet-based web-based meeting room | Yes; tablet | No | One group received the intervention (video); the comparator group received telephone-based care management | 5/13 |
| Kales et al [46] | WeCareAdvisor, a web-based tool for family caregivers, which guided them through a clinical reasoning process to identify, monitor, and manage behaviors while addressing their motivation, self-efficacy, and problem-solving skills | Yes; tablet | No | Waitlist for the tool; this group received the tool 1 month later | 8/13 |
| **Quantitative studies—quasi-experimental** | | | | | |
| Davis et al [63] | TelePrompt, a tablet-based, prompted voiding and educational intervention to support caregivers of older adults with urinary incontinence | Yes; tablet | No | No comparison group; the study was described by authors as a quasi-experimental, single-group pre-post design | 6/9 |
| Lai et al [44] | Telehealth delivered via videoconferencing platforms (apps) aimed at minimizing the possible negative impact of social distancing measures made necessary by the COVID-19 pandemic | No | No | Received a weekly care service via telephone covering information relevant to caregiving; did not receive the intervention of weekly health services delivered through video communication apps | 7/9 |
| Park et al [64] | Comprehensive Mobile Application Program, a tool providing real-time support to families caring for patients with dementia by helping family caregivers manage behavior and psychological symptoms | No | No | Comparator intervention was a handbook that contained the same information as the mobile app | 5/9 |
| Watcharasarnsap et al [42] | A mobile app system based on the reminiscence therapy framework; the app was developed to promote the relationship between caregivers and people with dementia and better the mental well-being of both parties | No | No | Control group did not use the intervention (no intervention) | 9/9 |
| **Quantitative studies—other (ie, noncomparative)** | | | | | |
| Callan et al [38] | A self-administered cognitive training intervention using an adaptive, paced serial attention task, targeting the dorsolateral prefrontal cortex, which is implicated in regulating emotions, anxiety, and stress | Yes; handheld computer | No | | N/A<sup>b</sup> | 6/10 |
| Study                          | Intervention description                                                                 | Hardware provided | Stakeholder input described | Comparator intervention (as applicable) | Study quality appraisal scores^a |
|-------------------------------|-------------------------------------------------------------------------------------------|-------------------|----------------------------|----------------------------------------|---------------------------------|
| Davis et al [43]              | An e-mobile multimedia app for community-based dementia caregiver support, designed to offer reassurance, information, and services to caregivers and facilitate the implementation of other interventions by nurses and therapists | Yes; mobile phone | No                          | N/A                                    | 1/10                            |
| Ptomey et al [47]             | A remotely delivered exercise intervention to increase moderate physical activity in caregivers | Yes; tablet       | No                          | N/A                                    | 4/10                            |
| Quinn et al [48]              | A mobile app designed to improve engagement of the patient-informal caregiver team; the mobile web-based app allowed older adult users to record social and health information and share this information with their caregivers | No                | No                          | N/A                                    | 4/10                            |
| Lai et al [39]                | A simple smartphone app for people with mild cognitive impairment and their family caregivers living in the community; the app supported communication with friends and family, navigation, and serving as a memory prompt and emergency alert system | Yes; mobile phone | No                          | N/A                                    | 6/10                            |
| Salin and Laaksonen [40]      | A multicomponent intervention, including live broadcasts related to caregiver self-care exercises, informational videos, and videoconferencing web-based meetings to connect informal caregivers | Yes; tablet       | Yes                         | N/A                                    | 2/10                            |
| Sourbeer et al [41]           | A preliminary tablet app developed for the Behavioral and Environmental Sensing and Intervention for Dementia Caregiver Empowerment; the goal of this app is to support the early detection of signs of agitation, allowing caregivers to intervene early | Yes; tablet       | No                          | N/A                                    | 2/11                            |

**Mixed methods studies**

| Study                          | Intervention description                                                                 | Hardware provided | Stakeholder input described | Comparator intervention (as applicable) | Study quality appraisal scores^a |
|-------------------------------|-------------------------------------------------------------------------------------------|-------------------|----------------------------|----------------------------------------|---------------------------------|
| Banbury et al [56]            | A telehealth peer-support program for isolated caregivers of people with dementia via group videoconferencing | Yes; not specified | No                          | N/A                                    | 3/8 and 3/10                    |
| Breebaart and van Groenou [57]| A groupware app for digital network communication to promote collaboration among informal and formal caregivers in a mixed care network of home-dwelling older adults | Yes; not specified | No                          | N/A                                    | 1/10 and 3/10                   |
| Brown et al [58]              | CareHeroes, an app providing caregivers with a platform for bidirectional sharing of observations and knowledge with providers about care recipients and, in so doing, provide them with information and support for caregiving activities | No                | Yes                         | N/A                                    | 4/10 and 3/10                   |
| Dam et al [59]                | Inlife, a web-based social support platform for caregivers of individuals with dementia aiming to enhance positive interaction, involvement, and social support | No                | No                          | Control group did not receive the intervention (waiting list) | 4/10 and 7/10                   |
| Sikder et al [60]             | A mobile app intervention delivering mentalizing imagery therapy (a guided imagery and mindfulness intervention) for family caregivers | No                | No                          | N/A                                    | 5/9 and 3/10                    |
| Study                  | Intervention description                                                                 | Hardware provided | Stakeholder input described | Comparator intervention (as applicable) | Study quality appraisal scores<sup>a</sup> |
|-----------------------|-------------------------------------------------------------------------------------------|-------------------|----------------------------|-----------------------------------------|------------------------------------------|
| Stutzel et al [61]    | A mobile phone app, The Mobile System for Elderly Monitoring, which aimed to support caregivers in monitoring care recipients with functional loss and to improve support for caregivers’ communication with the health team | Yes; mobile phone | Yes                        | N/A                                     | 5/10 and 7/10                            |
| Tyack et al [62]      | An art-based app intervention delivered via a touch screen tablet displaying art images aiming to stimulate and benefit the well-being of caregivers and care recipients with dementia | Yes; tablet       | Yes                        | N/A                                     | 6/9 and 8/10                            |
| **Qualitative studies**                                                                                                                                   |
| Garvelink et al [49]  | A decision support website to inform caregivers about ways of staying independent at home for as long as possible, called Supporting Seniors and Caregivers to Stay Mobile at Home | No                | No                         | N/A                                     | 3/10                                     |
| Hughes et al [50]     | A tablet app with multiple components, including games and a stress questionnaire for caregivers | No                | Yes                        | N/A                                     | 5/10                                     |
| Killin et al [51]     | The Digital Support Platform, an internet-based, postdiagnostic support tool for families of individuals who had recently received a diagnosis of dementia | Yes; tablet       | No                         | N/A                                     | 6/10                                     |
| Rathnayake et al [52] | Mobile health apps used for health information seeking                                     | No                | No                         | N/A                                     | 7/10                                     |
| Ruggiano et al [53]   | CareIT, a multifunctional smartphone and web-based app designed to meet the education and support needs of caregivers; the app allowed caregivers to self-assess for depression and burden and linked caregivers to resources | Yes; mobile phone | Yes                        | N/A                                     | 5/10                                     |
| Ryan et al [54]       | InspireD—Individual Specific Reminiscence in Dementia, a personalized reminiscence program for family carers and people living with dementia | Yes; tablet       | Yes                        | N/A                                     | 10/10                                    |
| Span et al [55]       | The DecideGuide, an interactive web tool that helps informal caregivers, people with dementia, and case managers make shared decisions | Yes; tablet       | Yes                        | N/A                                     | 5/10                                     |

<sup>a</sup>Complete quality appraisal tools and scores are presented in Multimedia Appendix 3.

<sup>b</sup>N/A: not applicable.
mHealth interventions included in the review also facilitated caregiving by (1) assisting with daily caregiving activities (eg, digital calendars to organize appointments, providing reminders for medication administration, helping caregivers manage care recipient behaviors, and tracking information related to the care recipient) [39,41,46,48,51,53,57,59,61,63,64]; (2) providing support for decisions related to care [46,49,55,58]; (3) providing information or education (eg, regarding the care recipient’s condition) [40,43-46,49,51-53,56,58,63,64], and (4) sending emergency alerts to the caregiver or to the care team if needed [39,61].

Finally, the mHealth interventions represented in the review promoted caregiver health and well-being by (1) monitoring or assessing caregiver stress, depression, and burden to facilitate early detection and intervention before reaching crisis levels [41,50,53,58,61]; (2) promoting self-care and healthy coping behaviors (eg, encouraging physical activity or suggesting evidence-based coping strategies for care recipient behaviors) [40,43,47,63,64]; and (3) providing therapeutic interventions (eg, art-based interventions [62], reminiscence therapy [42,54], cognitive training therapy [38], and mentalizing imagery therapy [60]).

Consideration of Factors That Influence Health Inequities

Figure 3 provides a visual summary of the number of studies that included or considered the factors listed in the PROGRESS-Plus framework in their report on (1) the design of their mHealth intervention, (2) participant recruitment, (3) study results or findings, and (4) study discussion or limitations.
Figure 3. Consideration of place of residence, race, occupation, gender, religion, education, social capital, socioeconomic status—plus age, disability, and sexual orientation (PROGRESS-Plus) factors in included studies.

Reporting of PROGRESS-Plus Factors in Intervention Design
When describing the design of their interventions, 36% (10/28) of studies provided considerations for ≥1 PROGRESS-Plus factor [37,40,41,46,48,49,56,59,61,63]. Approximately 11% (3/28) of studies considered the place of residence in their recruitment approaches as their interventions were designed specifically for geographically isolated caregivers [40,56,61]. Approximately 11% (3/28) considered languages through the provision of alternative language options in the mobile app, readability (ie, lay language), and accessibility options such as larger font or less text [37,46,49]. Approximately 11% (3/28) described social capital as an element of the intervention itself (eg, intervention aimed at providing a platform to organize and access social support) [56,59,63]. Approximately 7% (2/28) described considerations for caregivers’ age in the design of their interventions by improving readability, comprehensibility, and clarity of the language used in the intervention; providing caregivers with assistance in completing web-based forms; and integrating opportunities for regular check-ins to support mHealth tool use [41,46]. One of the studies considered gender or sex, as the intervention was tailored to address the unique needs of caregivers of different genders [46]. Another study considered socioeconomic status by deliberately selecting inexpensive mobile apps and devices [61]. Features of relationships between caregivers and care recipients were considered in the study design such that the mHealth intervention was a collaborative tool whereby older adults and their caregivers worked together on their health management [48]. None of the studies mentioned considering participants’ occupation, religion, education, disability, sexual orientation, or time-dependent relationships when describing the design of their mHealth interventions.

Reporting of PROGRESS-Plus Factors in Participant Recruitment
At the participant recruitment stage, 57% (16/28) of studies considered ≥1 PROGRESS-Plus factor [38,40,42,44-46,49,51-53,56-60,64]. Approximately 32% (9/28) considered features of relationships (eg, living situation) [38,40,44,46,51,52,58,60,64]. Approximately 18% (5/28) of studies reported that they used specific recruitment strategies to help ensure that various races, ethnicities, cultures, and languages were represented in their study samples (eg, recruiting from minority populations) [46,49,53,58]. Approximately 11% (3/28) of studies considered age (eg, recruiting older caregivers) [38,45,60].
Approximately 7% (2/28) of studies considered social capital (eg, recruiting caregivers with an existing social support network) [56,59] and 7% (2/28) considered disability (eg, excluding caregivers with sensory impairment) [38,46]. One of the studies considered time-dependent relationships (eg, excluding dyads where the care recipient was awaiting imminent institutional placement) [46], and another considered gender or sex [59] at the stage of participant recruitment. No studies mentioned occupation, religion, education, socioeconomic status, or sexual orientation during participant recruitment.

**Reporting of PROGRESS-Plus Factors in Results or Findings**

All but 1 study [54] described ≥1 PROGRESS-Plus factor within their results or findings. These factors were typically reported as part of the sample demographics. The key demographic characteristics of the caregivers in the included studies are presented in Table 2. The most commonly reported PROGRESS-Plus factors within the included articles’ results or findings were age and gender or sex [37-50,52,53,55-64]; features of relationships [37,39,40,42,43,45,46,48,49,51-53, 55-59,61,63]; education [37-39,44-46,50,52,55,56,58,61,63,64]; and race, ethnicity, culture, and language [38,41,43,45-49,53,58,60,62,63]. Other factors reported in the results or findings included socioeconomic status [38,44,48,53,61,63,64], social capital [48,55-57,59,61,64], place of residence [40,49,53,56,62,64], and occupation [50,52,56,61,63,64]. A small number of studies reported on caregivers’ disabilities [49,61,63], time-dependent relationships (eg, participants’ housing situation) [49,58], and religion [64]. No studies reported on sexual orientation in their results or findings.
| Study and country | Sample size | Age (years) | Sex, n (%) | Education, n (%) | Ethnicity, n (%) |
|-------------------|-------------|-------------|------------|------------------|-----------------|
| Banbury et al [56], Australia | 69 | Mean 62.6 (SD 13.54) | 50 (72.5) female, 19 (27.5) male | 6 (8.7) did not complete high school, 6 (8.7) completed high school, 17 (24.6) had technical and further education or trade, 24 (34.8) attended university, 16 (23.2) had postgraduate qualifications | Not reported |
| Beentjes et al [37], Netherlands | 59 | Experimental group mean 65.61 (SD 10.196); control group mean 68.03 (SD 11.675) | 38 (64.4) female, 21 (35.6) male | 12 (20.3) had secondary education (vocational), 8 (13.6) had secondary education (academic), 11 (18.6) had further education (vocational), 20 (33.9) had higher education (vocational), 8 (13.6) had higher education (academic) | Not reported |
| Breebaart and van Groenou [57], Netherlands | 7 | 1 (14.3%) middle-aged, 1 (14.3%) aged between 60 and 65, and 5 (71.4%) aged ≥70 | 3 (42.9) female, 3 (42.9) male, 1 (14.3) not specified | 4 (57.1) had low education, 2 (28.6) had average education, 1 (14.3) did not specify | Not reported |
| Brown et al [58], United States | 11 | Mean 56.6 (SD 13.6) | 9 (81.8) female, 2 (18.2) male | Not reported | 3 (27.3%) White, 7 (63.6%) African American, 1 (9.1%) Hispanic, 1 (9.1) other |
| Callan et al [38], United States | 27 | Mean 74.61 (SD 6.52) | 22 (81.5) female, 5 (18.5) male | 11 (40.7) had middle school to technical school education, 14 (51.9) had some college to college graduate education, 2 (7.4) had some postgraduate to postgraduate degree | 26 (96.3) White |
| Dam et al [59], Netherlands | 10 | Range 49-71 | 6 (60) female, 4 (40) male | Not reported | Not reported |
| Davis et al [43], United States | 4 | Mean 52 | 4 (100) female | Not reported | Not reported |
| Davis et al [63], United States | 3 | Range 54-85 | 3 (100) female | 2 (66.7) attended college, 1 (33.3) had a master’s degree | 3 (100) White |
| Garvelink et al [49], Canada and France | 10 | Mean 56.9 (SD 14) | 6 (60) female, 4 (40) male | 10 (100) had a university degree | Not reported |
| Hastings et al [45], United States | 40 | Mean 64.7 (SD 10.8) | 40 (100) female | Not reported | 11 (27.5) Black |
| Hughes et al [50], United States | 10 | Mean 60 (range 48-76) | 10 (100) female | 10 (100) had high school education, 9 (90) had higher education | Not reported |
| Kales et al [46], United States | 57 | Mean 65.9 (SD 14.0) | 43 (75.4) female, 14 (24.6) male | 48 (84.2) had greater than high school education, 9 (15.8) had high school or GEDa | 36 (63.2) White, 18 (31.6) African American, 3 (5.3) other |
| Study and country | Sample size | Age (years) | Sex, n (%) | Education, n (%) | Ethnicity, n (%) |
|-------------------|-------------|-------------|------------|------------------|-----------------|
| Killin et al [51], Scotland | 10 | Not reported | Not reported | Not reported | Not reported |
| Lai et al [44], Hong Kong, China | 60 | Experimental group mean 72.43 (SD 0.80, range 66-82); control group mean 71.83 (SD 0.80, range 66-82) | 35 (58.3) female; 25 (41.7) male | Experimental group: 7.90 (SD 0.25, range 5-11) years of education; Control group: 7.04 (SD 0.31, range 5-9) years of education | Not reported |
| Lai et al [39], Germany | 24 | Mean 62.4 y (SD 16.0, range 31-83) | 9 (37.5) female; 15 (62.5) male | 11 (45.8) had >12 years of education | Not reported |
| Park et al [64], South Korea | 24 | Experimental group mean 54.50 (SD 3.71); control group mean 61.00 (SD 6.42) | 14 (58.3) female; 10 (41.7) male | 15 (62.5) were high school graduates or below; 9 (37.5) were college graduates or above | Not reported |
| Ptomey et al [47], United States | 9 | Mean 67 | 3 (33.3) female; 6 (66.7) male | 3 (33.3) had high school diploma or GED; 6 (67.6) attended postgraduate classes | 8 (88.9) White; 1 (11.1) Black |
| Quinn et al [48], United States | 12 | Mean 54.8 (SD 13.3) | 11 (91.7) female; 1 (8.3) male | 6 (50) had a business or some college degree or graduate degree; 6 (50) graduated school | 6 (50) Black; 6 (50) White |
| Rathnayake et al [52], Australia | 10 | 8 (80%) aged <65; 2 (20%) aged ≥65 | 9 (90) female; 1 (10) male | 5 (50) had high school education and below; 5 (50) had above high school education | Not reported |
| Ruggiano et al [53], United States | 36 | Mean 65.7 (range 42-89) | 26 (72.2) female; 10 (27.8) male | Not reported | 13 (36.1) non-Hispanic White; 23 (63.9) African American |
| Ryan et al [54], United Kingdom | 17 | Mean 69.1 (SD 15.1, range 31-91) | 13 (76.5) female; 4 (23.5) male | Not reported | Not reported |
| Salin and Laaksonen [40], Finland | 20 | Range 61-88 | 15 (75) female; 5 (25) male | Not reported | Not reported |
| Sikder et al [60], United States | 17 | Mean 66.52 (SD 9.61) | 12 (70.6) female; 5 (29.4) male | Not reported | 17 (100) White |
| Sourbeer et al [41], United States | 46 | 42 (91.3%) aged >60; 4 (8.7%) aged <60 | 38 (82.6) female; 8 (17.4) male | Not reported | 39 (84.8) White; 6 (13.0) African American; 1 (2.2) Hispanic |
| Span et al [55], Netherlands | 12 | Mean 54.3 (range 19-86) | 7 (58.3) female; 5 (41.7) male | 1 (8.3) had low education; 4 (33.3) had medium education; 6 (50) had high education; 1 (8.2) did not specify | Not reported |
| Stutzel et al [61], Brazil | 38 | Mean 61 (SD 10.75) | 32 (84.2) female; 6 (15.8) male | 21 (55.3) had ≤12 years of education; 17 (44.7) had >12 years of education | Not reported |
| Tyack et al [62], United Kingdom | 12 | Mean 66 (range 48-77) | 10 (83.3) female; 2 (16.7) male | Not reported | 12 (100) White |

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burden was similar before and after the mHealth intervention
related to the management of urinary incontinence, found that
of the studies, which specifically assessed caregiver burden
improvements in caregiver burden [43,44,46,64]. However, one
Inventory [65] found that mHealth interventions led to
Approximately 14% (4/28) of studies using the Zarit Burden
certainty [46], or positive caregiving experience [37].
knowledge improved after the implementation of an mHealth
Although some studies found that caregiving self-efficacy and
experience [37], positive care orientation in their discussion or limitations sections.
Other PROGRESS-Plus factors described in the study discussions or limitations were gender or sex
[38,41,52,55,63], education [37,38,49,52,63], and socioeconomic status [44,47,52,53,63]. To a lesser extent,
caregivers’ social capital [48,56,59], disabilities [38,49], features of relationships (eg, nature of relationship between caregiver and care recipient) [54,55], and time-dependent relationships (eg, the impact of COVID-19 on the amount of time caregivers could spend visiting the care recipient) [37,49] were also discussed. No studies considered occupation, religion, or sexual orientation in their discussion or limitations sections.

Quantitative Caregiver Outcomes

Outcomes Relating to Caregiving

Approximately 21% (6/28) of studies assessed outcomes related to caregivers’ physical health and well-being [37,40,44,46,50,51,53,54,60,62,63]. Impacts on caregivers’ mental and psychological health status were assessed in 25% (7/28) of studies [42,44,46,60-62,64], with generally positive results. Specifically, mental health status [44], psychological well-being [42], depression [46,60], mood [60], distress [46], and fatigue [64] were each noted to have improved after the implementation of an mHealth intervention. For example, the implementation of the WeCareAdvisor tool, designed to provide caregivers with peer navigation, information, and daily messaging, led to significant improvement in self-reported distress (−6.08, SD 6.31 points; P<.001) [46]. In this study, those in the control group demonstrated a significant decrease in their confidence in caregiving (−6.40, SD 10.30; P=.002) [46]. Conversely, a study that assessed caregiver stress by testing cortisol levels in saliva in a pretest-posttest design found no differences after the use of an mHealth intervention designed to manage the behavioral and psychological symptoms of dementia [64]. Caregivers’ self-appraised happiness was also unchanged after the intervention in one of the studies [62].

Approximately 11% (3/28) of studies assessed outcomes related to caregivers’ physical health and well-being [44,47,64]. Caregivers self-reported improvements in their general physical health status following the use of an mHealth intervention to support the well-being and community living of older adults and their spousal caregiver dyads [44]. Ptomey et al [47], who implemented an mHealth app to encourage exercise, observed that caregivers’ weekly moderate physical activity increased by 49 minutes (30% increase) per week over the 12-week intervention period, whereas light physical activity increased by 11.6 minutes (3% increase) per week. However, Park et al [64] found no difference in caregivers’ sleep quality after the implementation of a supportive mHealth app.

Approximately 14% (4/28) of studies used the Zarit Burden Inventory [65] found that mHealth interventions led to improvements in caregiver burden [43,44,46,64]. However, one of the studies, which specifically assessed caregiver burden related to the management of urinary incontinence, found that burden was similar before and after the mHealth intervention [63]; however, study investigators noted that the intervention did not worsen caregiver burden [63].

Outcomes Relating to Caregivers’ Health and Well-being

Approximately 39% (11/28) of studies assessed the impact of mHealth interventions on various aspects of caregivers’ health and well-being [37,40,44,46,47,60-62,64]. Impacts on caregivers’ mental and psychological health status were assessed in 25% (7/28) of studies [42,44,46,60-62,64], with generally positive results. Specifically, mental health status [44], psychological well-being [42], depression [46,60], mood [60], distress [46], and fatigue [64] were each noted to have improved after the implementation of an mHealth intervention. For example, the implementation of the WeCareAdvisor tool, designed to provide caregivers with peer navigation, information, and daily messaging, led to significant improvement in self-reported distress (−6.08, SD 6.31 points; P<.001) [46]. In this study, those in the control group demonstrated a significant decrease in their confidence in caregiving (−6.40, SD 10.30; P=.002) [46]. Conversely, a study that assessed caregiver stress by testing cortisol levels in saliva in a pretest-posttest design found no differences after the use of an mHealth intervention designed to manage the behavioral and psychological symptoms of dementia [64]. Caregivers’ self-appraised happiness was also unchanged after the intervention in one of the studies [62].

Reporting of PROGRESS-Plus Factors in Discussion or Limitations

Approximately 79% (22/28) of studies considered ≥1 PROGRESS-Plus factor in the discussion or limitations sections of their studies [37,38,40,41,43,44,47-56,58-63]. The most frequently discussed PROGRESS-Plus factors in the included articles’ discussion or limitations were age [37,38,40,41,43,48,50,51,53,54,60,62,63], as challenges faced by older caregivers in using mobile devices; race, ethnicity, culture, and language [40,41,43,47,49,52,53,55,58,60], such as a lack of diversity of the study sample; and place of residence [40,44,47,49,51,53,55,56,61], such as challenges related to the lack of access to stable internet in rural locations. Other PROGRESS-Plus factors described in the study discussions or limitations were gender or sex [38,41,52,54,55,63], education [37,38,49,52,63], and socioeconomic status [44,47,48,52,53,63]. To a lesser extent, caregivers’ social capital [48,56,59], disabilities [38,49], features of relationships (eg, nature of relationship between caregiver and care recipient) [54,55], and time-dependent relationships (eg, the impact of COVID-19 on the amount of time caregivers could spend visiting the care recipient) [37,49] were also discussed. No studies considered occupation, religion, or sexual orientation in their discussion or limitations sections.

Study and country | Sample size | Age (years) | Sex, n (%) | Education, n (%) | Ethnicity, n (%)
---|---|---|---|---|---
Watcharasarnsap et al [42], Thailand | 60 | 8 (13.3%) aged between 18 and 27, 19 (31.7%) aged between 28 and 37, 15 (25%) aged between 38 and 47, 10 (16.7%) aged between 48 and 57, and 8 (13.3%) aged ≥58 | • 31 (51.7) female • 29 (48.3) male | • Not reported | • Not reported

GED: General Educational Development.
therapeutic reminiscence, respectively. Salin and Laaksonen [40] observed that some aspects of quality of life, in fact, worsened, albeit mildly (breathing, sexual activity, vitality, depression, and usual activities). One of the studies assessed the impact of an mHealth intervention on caregivers’ social engagement and found high positive responses using the Kaye Gain Through Involvement Scale [66], suggesting that the gains in well-being experienced while using the mHealth intervention may be applicable when tested in a larger sample [43]. However, the study investigators noted that their sample was meant only for determining intervention efficacy and warranted testing with a larger sample [43].

Outcomes Related to Usability, Feasibility, and Acceptability of mHealth Interventions

Half of the reviewed studies assessed outcomes related to the usability, acceptability, or feasibility of mHealth interventions for caregivers of older adults [38-41,45,47,48,57-63]. Approximately 32% (9/28) of studies measured the usability or ease of use of mHealth interventions by caregivers [40,41,45,47,48,58,59,61,63]. Approximately 14% (4/28) of articles used the System Usability Scale [67] to do so; usability scores varied across studies, ranging from marginally acceptable [45], moderate [48], and good to excellent [61]. Only 4% (1/28) of studies compared the system usability scores across 2 phases of their mHealth app intervention. Sourbeer et al [41] found that usability did not significantly improve in a subsequent version of their mHealth app updated in response to participant feedback. The remaining 18% (5/28) of studies assessed caregivers’ ease of use or perceived user-friendliness of the mHealth intervention using descriptive statistics or averaged Likert scale scores. These studies generally reported positive results, suggesting that caregivers believed the interventions were easy or very easy to use [40,47,58,59,63]. Approximately 21% (6/28) of studies examined caregivers’ satisfaction or positive feelings toward the intervention [39,40,47,48,58-61]. Most reported that caregivers were generally satisfied with the mHealth intervention, perceived the intervention as relevant and useful to their caregiving activities, and felt positive about their experiences with the intervention [39,40,47,48,58-61]. However, greater technical difficulties were reported in a study of participants who lived rurally and reported lower levels of satisfaction [40].

Approximately 29% (8/28) of studies explored the feasibility of an mHealth intervention by measuring the regularity, frequency, and extent of its use by caregivers over the intervention period [38,57-60,62]. Use varied across the included studies, and investigators did not consistently establish expectations of use for their participants nor defined what constituted adequate use of the intervention. Tyack et al [62] reported that the participants used their app at least five times during the intervention period, as suggested by the study investigators. Callan et al [38] found that 22 out of 27 (81.5%) caregivers used the mHealth intervention regularly (as defined by the study investigators as at least 3 weeks out of the 4-week intervention period). Baseline caregiver stress, worry, and sleep quality did not adversely affect the use of the mHealth intervention, and caregivers with the highest self-reported stress and worry reported the highest levels of mHealth intervention use [38]. Sikder et al [60] reported that over half of their 17 study participants accessed ≥75% of the informational documents in their mHealth app. The remaining 11% (3/28) of studies reported varying frequencies or hours of use per week during the intervention period [57-59]; however, these studies did not comment on whether these frequencies constituted low, medium, or high use of their mHealth interventions.

Approximately 11% (3/28) of studies assessed feasibility by measuring the intervention attendance and retention of caregivers during the intervention period [40,45,47]. The attendance rates for caregivers varied from 72% (13.7/19) [40] to 97.1% (34/35) [45]. Proney et al [47] and Hastings et al [45] reported similar figures (7/9, 78% dyads, and 31/40, 78% dyads, respectively) for the caregiver–care recipient dyads completing their interventions.

Other feasibility measures used by the reviewed studies included the extent to which caregivers followed or adhered to the mHealth intervention [38,63]. Callan et al [38] reported that caregivers’ continued engagement in a cognitive training mHealth intervention program was evidenced by improvements in their ability to perform cognitive training tasks. Davis et al [63] reported that caregivers were capable of learning and implementing the prompted toileting strategies to support care recipients with the help of an mHealth intervention, as evidenced by a reduction in care recipient wetness in 2 out of 3 participant dyads.

Qualitative Caregiver Findings

Overview

Of the 28 studies, 7 (25%) qualitative studies and 7 (25%) mixed methods studies presented findings relating to caregivers’ experiences with mHealth interventions [49-62]. These qualitative findings included (1) positive impacts of caregivers’ experiences with mHealth interventions, (2) challenging aspects of caregivers’ experiences with mHealth interventions, (3) barriers to caregivers’ engagement with mHealth interventions, and (4) caregivers’ suggestions to improve mHealth interventions.

Positive Experiences With mHealth Interventions

Most studies highlighted promising findings related to the positive impacts of caregivers’ experiences with mHealth interventions. Participants across the included studies found mHealth interventions to be helpful, user-friendly, and easy to understand [49,50,54,55]. mHealth interventions were perceived to help caregivers connect with the care team and provide care for their loved ones [53,55,57,60,61]. The information provided through mHealth interventions was described as relevant to addressing participants’ educational needs [49,52]. Caregivers also valued the role of mHealth interventions in detecting their stress levels [50] and facilitating timely connections to a diverse range of professional services and social support [49,52,54,56,62]. Participants in the included studies reported benefits to their emotional and cognitive well-being [60,62] and described reappraising and feeling closer to the care recipient [54,62]. The mobile delivery of the interventions also contributed to feelings of safety and security, as caregivers could...
participate from their homes [54,56]. Although some participants initially felt a lack of confidence in using technology, caregivers in 7% (2/28) of studies reported becoming more engaged and comfortable over time by integrating the mHealth intervention into their lives [54,57].

**Challenging Experiences With mHealth Interventions**

Several studies described the negative aspects of caregivers’ experiences with using mHealth interventions, although these were often reported as being applicable to only a minority of participants. Approximately 11% (3/28) of studies indicated that some participants felt that the mHealth intervention was too complex or difficult to understand [49,51,60]. In another study, participants felt that the intervention included questions that were overly obtrusive or confronting; for example, participants were not always comfortable answering questions they perceived as challenging [55]. Some studies highlighted caregivers’ concerns regarding the potentially detrimental impacts of mHealth interventions; for example, interventions that facilitated reminiscence could trigger painful memories and lower mood [54,62]. Hughes et al [50] further described caregivers’ concerns regarding the diversion of their time and attention toward the mHealth intervention and away from the care recipient. One of the studies highlighted the preference of some participants for in-person interventions, citing physical contact as an important element of care (eg, hugging), which was not possible in a digital environment [56].

**Barriers to Caregivers’ Engagement With mHealth Interventions**

Caregivers relayed frustration with the usability of mHealth interventions, including difficulties navigating the intervention on their mobile devices [49,50,62]. Challenges included print that was too small [49,50], screens that were overly sensitive or had too much glare [62], and language that was too complex [49]. Several studies highlighted a lack of familiarity or experience with technology as a key barrier to the use of mHealth interventions, particularly for older caregivers [51-53,55]. The busy schedules of caregivers for older adults were also identified as a barrier to regular mHealth intervention use, particularly if caregivers were often pulled away from their devices by care recipients or if they were experiencing health issues themselves [50,52,58,60].

In other cases, participants felt that the intervention’s content was not relevant to their immediate needs [49,51] or lacked realism (eg, lack of ethnic diversity among actors portraying caregivers in the mHealth intervention) and up-to-date links to relevant resources [49]. Other barriers included the prohibitive cost of mobile devices and internet or data plans [52] and the availability of a stable internet connection in rural regions [56].

**Caregivers’ Perspectives Regarding Next Steps**

Qualitative findings frequently incorporated participants’ suggestions to make mHealth interventions more user-friendly and accessible to caregivers. Suggestions included simplifying the intervention’s interface or instructions, enlarging text and images, and including subtitles on video resources for individuals with hearing impairment [49,52,61,62]. Participants voiced the need for ongoing technical support, particularly for caregivers who were unfamiliar with using mobile devices [51,56].

The participants also made suggestions to develop more relevant and up-to-date content for mHealth interventions. Several studies highlighted the need to embed local and national services for caregiver support, including interventionists and respite care [58-60]. For interventions that targeted the caregiver–care recipient dyad, participants highlighted the need for more information specifically related to their own health, such as healthy coping [49,52,58,61]. Participants also called for greater emphasis on topics that caregivers often find difficult, including information about deciding to move to a care home, managing activities of daily living and aggressive behaviors, and resources for individuals experiencing abuse [49,52,58].

Other findings suggested to improve mHealth engagement among caregivers included greater ethnic diversity portrayed within the mHealth intervention [49], establishing a reward system to encourage regular use [50], and creating a component for the care recipient to be included when the caregiver uses the mHealth intervention [50].

**Discussion**

**Principal Findings**

This systematic review examined how health and social equity are considered in the design, implementation, and evaluation of mHealth interventions developed for caregivers of older adults using the PROGRESS-Plus framework. The interventions described in the included studies were designed to create linkages between caregivers and external supports, streamline and optimize caregiving activities, and encourage a focus on caregiver health and well-being. As such, evidence on the impacts of caregiver-focused mHealth interventions was synthesized across a range of outcomes.

The findings indicate that health and social factors are not consistently taken into consideration when designing research studies (ie, used to develop and guide recruitment and intervention design). Furthermore, participant characteristics are most often only reported within study results when summarizing participant characteristics or when identifying limits to the generalizability of the findings. However, this review highlights how mHealth interventions are well-positioned to improve caregivers’ self-efficacy and knowledge, their perceived mental and physical wellness, and their relationships with care recipients. The usability and acceptability of mHealth interventions were characterized by ease of use, ease of navigating technical challenges, and relevance of intervention content to the caregivers’ individual roles and context.

**Consideration of PROGRESS-Plus Factors in Studies on mHealth Interventions for Caregivers of Older Adults**

**Overview**

Most studies in this systematic review on mHealth interventions for caregivers of older adults considered some PROGRESS-Plus factors, particularly when describing their study samples. However, such demographic reporting reflects standardized
reporting practices of participant composition rather than
deliberate and targeted approaches to recruiting caregivers across
sociodemographic characteristics to determine whether an
intervention is suitable for a diversity of participants. The factors
described in the following sections were considered critical in
the intervention design.

**Gender Sex or Sexual Orientation**

Importantly, few studies considered actively recruiting
caregivers of different self-reported genders or considered the
relevance of gender in intervention design or implementation.
Research suggests that biological and gender differences affect
health across a range of parameters such as risk, disease
incidence, and the need for health services [27]. Furthermore,
sexual orientation was, in fact, eclipsed across all studies,
particularly when many studies focused on caregiver health and
well-being, which includes the relationship they have with care
recipients. Recent evidence indicates that sexual and gender
minority caregivers, such as those identifying as queer and
transgender, report higher depressive symptoms (78%) than the
overall population of caregivers of people with dementia (34%) [68].
This finding highlights the importance of diversifying samples across genders and sexual orientations to reliably assess
and address caregivers’ mental health. The importance of
considering the intersections among gender, sexual orientation,
and other sociodemographic factors was also highlighted in the
survey of a cross-sectional sample of members of the National
Alliance for Caregiving. Caregivers who identified as lesbian,
gay, bisexual, and transgender were more likely to be racially
and ethnically diverse and represent lower socioeconomic
classes than those who did not [69].

**Education**

Education, although frequently reported in demographics, was
also rarely considered as an important factor in informing
intervention design and recruitment. Women with lower
education are more likely to assume caregiving roles than those
who have had additional educational opportunities [11]. Lower
literacy levels among caregivers can affect their ability to
navigate the health system and locate appropriate support for
themselves and their care recipient [70], factors that can directly
influence the design and usability of mHealth interventions. For
element, lower literacy can affect comprehension of text-based
content in mHealth apps, the ability to correctly enter spelled
words in search functions, and the ability to navigate app menus
[71]. The importance of designing mHealth interventions that
account for varying levels of educational background is
underscored by the association of literacy with health and digital
literacy [72].

The findings of the included studies suggest that experience
with technology can be a key barrier to the use of mHealth
interventions, particularly among older caregivers [51-53,55].
A survey of a broad age range of caregivers suggests that
younger caregivers (aged <50 years) are more than twice as
likely than older caregivers to be receptive to using mHealth
apps to support them in their caregiving roles [24]. For older
adults, trust in technology as it relates to privacy and access to
information can be an important factor in the use of mHealth
interventions, especially given the heterogeneity of this
population [24,73]. These findings suggest that exploring
barriers and facilitators, as identified by the included qualitative
studies, aimed at educating older adults on how to use mHealth
interventions is essential to facilitate perceived trust, comfort,
and usability of technology. Thus, beyond education as a social
determinant of health, wide disparities exist across caregivers
in comfort with using various technologies, such as tablets,
 iPads, and mobile phones [73].

**Socioeconomic Status**

Socioeconomic status was minimally considered in the
intervention design and was most often addressed when
describing sample characteristics. Multiple studies reported
providing participants with devices to support the use of
mHealth apps [37-41,43,45-47,51,53-57,61-63]. In some cases,
participants were allowed to keep the devices; however,
especially in those instances in which they were not, the
feasibility of such interventions for caregivers across income
levels needs to be explored.

Some interventions were designed to facilitate communication
access to health professionals and other individuals (eg, support
groups), highlighting the need for access to a reliable internet
connection. This lack of access may be due in part to financial
constraints, as a survey of caregivers in the United States found
that cost was a commonly reported barrier to the use of
technology [74]. Furthermore, older adults living on fixed
incomes may be reticent to spend money on devices they do
not value or find overly complicated [75]. Importantly, older
caregivers tend to have fewer technological devices than their
younger peers, and these technologies are often used for
communication purposes rather than health management
purposes [18]. Although most caregivers report valuing
technology, those that use it for health-related activities tend to
use it for targeted caregiving activities such as medication
tracking or safety [18]. Therefore, additional support or
education may be required to increase caregiver uptake of
mHealth interventions as a tool for addressing broader caregiver
needs such as communication with health teams or liaising with
other caregivers. Computers and smartphones are increasingly
being owned by people with higher income and education, and
the provision of caregiver support through mHealth apps could
increase inequalities if economic resources are not considered
in the design and implementation of these interventions [71].

**Culture, Language, and Race**

The nature of caregiver–care recipient relationships can be an
important factor in the design of mHealth tools, particularly
when it comes to cultural expectations of family members,
gender roles, and other caregiver demographics. The included
studies had samples primarily made up of women, validating
the literature that suggests women are most likely to provide
caregiving support, corroborating cultural norms across a range
of identities [76]. However, these studies did not address how
intersecting identities (eg, culture, gender, race and ethnicity,
and socioeconomic status) might shape expectations and
responsibilities within a caregiving role [11,12,68]. Research
suggests that culture strongly affects caregiving but that cultural
influences on the caregiver role must be understood within the
context of race and gender socialization [77]. For example,
individualistic or Western notions of strategies to address caregiver burdens, such as spending time alone or sharing caregiving responsibilities with friends or family, might not resonate with caregivers from other cultures, particularly those with a strong sense of filial responsibility or immigrant caregivers without local support [78]. Furthermore, mHealth apps not provided in caregivers’ first languages decrease accessibility and would require careful translation and cultural adaptation to remain meaningful [79]. The impact of these factors on caregiver-specific outcomes, such as caregiving self-efficacy, health and well-being, and technology usability, is yet to be explored. Intersecting identities are increasingly important to consider when tailoring web-based caregiver interventions to participants’ individual needs [19].

mHealth Interventions Developed for Caregivers of Older Adults

Impacts of mHealth Interventions on Caregiver Health and Wellness

Studies evaluating mobile technology interventions aiming to promote caregivers’ perceived mental and psychological health reported benefits to their emotional and cognitive well-being [60,62]. Some of these interventions, such as the videoconferencing platform developed by Lai et al [44], were designed in lieu of in-person community services, following shelter-in-place orders during the COVID-19 pandemic. Connecting caregivers to professional and peer support using web-based technologies has been shown to improve mental health outcomes and can help caregivers overcome common access-related barriers related to PROGRESS-Plus factors, such as geographical and time constraints or community mobility limitations related to physical or mental health [18-20]. However, findings from the included studies suggest that caregivers still require opportunities for in-person interaction (eg, hands-on training from a health care provider to successfully use external support systems), suggesting that the impact of hybrid models of interventions to improve caregiver health and wellness is not well understood [20]. Furthermore, a review of these interventions using the PROGRESS-Plus factors suggests that, although caregivers stand to benefit from mHealth interventions and many older adults report being comfortable with smartphone use, uptake may continue to be constrained if support is not provided to help caregivers learn and familiarize themselves with mHealth apps at the outset [80]. Hybrid approaches have the potential to increase caregiver self-efficacy, as opposed to overwhelming caregivers with new tools and technology, which warrants further research.

Supporting the Caregiver Role Through mHealth Interventions

Caregivers’ ability to perform their roles was a key focus of the examined mHealth interventions and outcomes of interest within the included studies. Although some interventions focused on creating external structures that facilitated responsibilities of providing care (eg, medication alarms, and checklists), the use of these tools had the potential to complicate caregiving responsibilities. For example, in one case, caregivers described that the increased screen time to engage in the intervention was taking away from the time they had to complete other caregiving tasks [58]. The impact of such detrimental experiences, as they relate to, for example, PROGRESS-Plus factors of gender-informed cultural caregiving roles, features of relationships, or caregiver disability, is not well understood. Wasilewski et al [34] found that caregivers’ decline in web-based intervention use may be attributed to a malalignment with their specific needs and capabilities across the caregiving trajectory. In such cases, it is important for those recommending mHealth interventions to caregivers to consider whether a particular intervention itself might increase the caregiver burden [81]. Furthermore, research suggests that if older adults perceive an mHealth app to be beneficial to their health and well-being, their likelihood of ongoing and increased engagement with other apps increases [82]. Individualized tailoring of mHealth apps and providing the necessary access and universal design can foster equitable uptake and increase the potential benefits of mHealth interventions.

Usability, Feasibility, and Acceptability of mHealth Interventions

Overall, caregivers in the included studies were generally comfortable using mHealth interventions and reported positive impacts on their caregiving role [49,50,54,55]. However, findings such as the prohibitive costs associated with mobile devices and internet and data plans, in combination with the quality of internet provision to those living in rural settings, highlight the importance of equitable service provision across the PROGRESS-Plus factors [52,56]. The findings of this review also showed that 64% (18/28) of studies [37-41,43,45-47,51,53-57,61-63] provided participants with the devices required to engage in the interventions, suggesting that the economic feasibility of these interventions needs to be better understood.

Technical features such as app use data may provide valuable insights into the frequency and applicability of interventions to caregiver needs and their unique lifestyles. Furthermore, researchers have been urged to include older adults and their caregivers in the design and development of mobile app technologies [48]. However, a minority of the studies included in this review described stakeholder input as a component of their intervention design or implementation [40,50,53-55,58,61]. Co-design approaches present important opportunities for engaging diverse populations to help ensure that mHealth interventions are inclusive and accessible.

Implications

Moving forward, an important reminder is that social determinants of health should be consciously considered in all aspects of mHealth intervention design and implementation to avoid perpetuating inequities experienced by historically and currently systemically disadvantaged caregivers of older adults living with chronic conditions [25,83]. Purposeful efforts to include a diverse range of participants in research, such as evidence-based recruitment strategies, can help redress these potential inequities and inform the development of more inclusive interventions [84,85]. The PROGRESS-Plus framework is an appropriate tool to help ensure that a health
and social equity lens is applied in research design and reporting, the use of which should be widely endorsed [27,86].

This review highlights the need for high-quality mHealth studies. Particular attention must be paid to improving the design of mHealth interventions and ensuring equality in access and adoption of mHealth interventions [71]. Participatory action approaches to research, such as co-design, are ideal for ensuring that mHealth interventions meet the needs of diverse caregivers. Furthermore, inclusive design principles can be used in more traditional research methodologies to ensure that mHealth interventions do not amplify health disparities. This could be achieved by accommodating low literacy by including audio narration and visual depictions or by directing funding to increase access to human resource infrastructures (eg, technical support) that promote mHealth interventions in remote or low-income regions [71].

Strengths and Limitations

The studies included in this systematic review represent the diversity of mHealth interventions that have been conceptualized and created to address caregiver needs. Unfortunately, many studies were found to be poorly designed and executed. Although half of the included studies assessed usability, feasibility, and acceptability of mHealth interventions, which are all important aspects of technology use, many of these used qualitative approaches and lacked overall methodological rigor. Given the variety of mHealth apps, technological devices, and implementation protocols, equivalent comparisons could not be made across studies. A small number of studies were identified evaluating the impact of caregiver-focused interventions on caregiver-specific outcomes, limiting the ability to make conclusive recommendations to guide practice. Encouragingly, some of the included quantitative studies that used valid and reliable standardized tools thoroughly described their approach to statistical analysis and generally addressed fidelity of intervention delivery.

In this review, multiple steps were taken to achieve methodological rigor. The review was conceptualized and designed using an equity framework and the best evidence on interventions for caregivers of older adults. The search strategy was developed in consultation with a health research librarian, and database searches, screening, data extraction, and risk of bias evaluations were conducted in duplicate, with a strong agreement between reviewers. The review protocol was also made publicly available a priori and was adhered to without any deviations. In addition, the PRISMA and PRISMA-Equity guidelines guided each phase of this study [28,87].

Inevitably, this study has some limitations. Although these searches were conducted by health and rehabilitation investigators across 3 large academic institutions in the Global North, these institutions use similar health research databases and search algorithms, which can affect future reproducibility (ie, replicating searches in different institutions with different journal access). The identification of potentially eligible literature from the Global South, other disciplines beyond health research (eg, technology literature databases), or those that are categorized in other ways (eg, gray literature) is another limitation of this review. However, this study highlights that research on mHealth interventions for caregivers of older adults primarily occurs within applied health settings. As such, future reviews should examine non-peer-reviewed evidence such as reports and program evaluations produced by the government and health authorities that trial mHealth interventions.

This study could have been further strengthened by involving additional team members, such as administrators of clinical settings who would implement mHealth interventions and, most importantly, caregivers of older adults themselves. By selecting the PROGRESS-Plus framework as a theoretical guide, this study did not examine the included interventions and investigations in light of compounding factors that disadvantaged caregivers (eg, impact of the intervention on older women living in rural settings) or capture other health and social factors beyond the framework (eg, access to health insurance). However, using the framework as an approach to name and identify how key individual factors have been considered in intervention design and evaluation, this study has set the stage for future investigations that examine the confluence of multiple social determinants of health.

Conclusions

mHealth supports are well-positioned to support caregivers of older adults by providing them with information, communication, and assistance in their caregiving role. However, access, uptake, and the ability to benefit from this technology can be affected by the social determinants of health and inequities among caregivers. This systematic review of mHealth interventions to support caregivers of older adults suggests that these tools are well-received by caregivers and have the potential to support caregivers across a variety of parameters by facilitating education, communication, and a sense of security for caregivers. The social determinants of health and equity factors are not widely considered in the design and implementation of mHealth interventions, although these parameters are frequently collected for demographic reporting. Recognizing that there are many challenges in designing and implementing mHealth interventions that are equitable, going forward, it will be important to strive for greater inclusion of the social determinants of health at all stages of mHealth development and implementation if there is to be widespread successful uptake of this supportive technology.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Search strategies for all databases.
Multimedia Appendix 2
Summary table of included studies.

Multimedia Appendix 3
Risk of bias assessments.

References

1. Evidence profile: caregiver support. World Health Organization. 2017. URL: https://www.who.int/ageing/health-systems/icope/evidence-centre/ICOPE-evidence-profile-caregiver.pdf?ua=1 [accessed 2021-08-15]

2. Liu Z, Heffernan C, Tan J. Caregiver burden: a concept analysis. Int J Nurs Sci 2020 Oct 10;7(4):438-445 [FREE Full text] [doi: 10.1016/j.ijnss.2020.07.012] [Medline: 33195757]

3. Roth DL, Fredman L, Haley WE. Informal caregiving and its impact on health: a reappraisal from population-based studies. Gerontologist 2015 Apr;55(2):309-319 [FREE Full text] [doi: 10.1093/geront/gnu093] [Medline: 26035608]

4. Wolff JL, Mulcahy J, Huang J, Roth DL, Covinsky K, Kasper JD. Family caregivers of older adults, 1999-2015: trends in characteristics, circumstances, and role-related appraisal. Gerontologist 2018 Nov 03;58(6):1021-1032 [FREE Full text] [doi: 10.1093/geront/gnx093] [Medline: 28637266]

5. Ploeg J, Garnett A, Fraser KD, Baird LG, Kaasalainen S, MaIney C, et al. The complexity of caregiving for community-living older adults with multiple chronic conditions: a qualitative study. J Comorb 2020;10:2235042X20981190 [FREE Full text] [doi: 10.1177/1041610219817289]

6. Peacock S, Sethi B, Williams A, Duggleby W, Baily M, Swindle J, et al. Older adult spouses with multiple chronic conditions: challenges, rewards, and coping strategies. Can J Aging 2017 Jun;36(2):209-222. [doi: 10.1017/S07014908081700095] [Medline: 28349856]

7. Wolff JL, Spillman B. Older adults receiving assistance with physician visits and prescribed medications and their family caregivers: prevalence, characteristics, and hours of care. J Gerontol B Psychol Sci Soc Sci 2014 Nov;69 Suppl 1:S65-S72 [FREE Full text] [doi: 10.1093/geronb/gbu119] [Medline: 25342825]

8. Vaingankar JA, Chong SA, Abdin E, Picco L, Jeyagurunathan A, Zhang Y, et al. Care participation and burden among informal caregivers of older adults with care needs and associations with dementia. Int Psychogeriatr 2016 Feb;28(2):221-231 [FREE Full text] [doi: 10.1017/S104161021500160X] [Medline: 26478530]

9. Born J, Baks P, Schut F, van Doorslaer E. The impact of informal caregiving for older adults on the health of various types of caregivers: a systematic review. Gerontologist 2019 Sep 17;59(5):e629-e642 [FREE Full text] [doi: 10.1093/geront/gny137] [Medline: 30395200]

10. Musich S, Wang SS, Kraemer S, Hawkins K, Wicker E. Caregivers for older adults: prevalence, characteristics, and health care utilization and expenditures. Geriatr Nurs 2017;38(1):9-16 [FREE Full text] [doi: 10.1016/j.gerinurse.2016.06.017] [Medline: 27477086]

11. Hengelaar AH, Wittenberg Y, Kwekkeboom R, Van Hartingsveldt M, Verdonk P. Intersectionality in informal care research: a scoping review. Scand J Public Health 2021 Jul 07:14034948211027816 [FREE Full text] [doi: 10.1177/14034948211027816] [Medline: 34232094]

12. Cook SK, Cohen SA. Sociodemographic disparities in adult child informal caregiving intensity in the United States: results from the new national study of caregiving. J Gerontol Nurs 2018 Sep 01;44(9):15-20. [doi: 10.3928/00989134-20180808-05] [Medline: 30148528]

13. Garnett A, Ploeg J, Markle-Reid M, Strachan PH. Formal health and social services that directly and indirectly benefit stroke caregivers: a scoping review of access and use. Can J Nurs Res 2022 Jun;54(2):211-233 [FREE Full text] [doi: 10.1177/0844562121101926] [Medline: 35130749]

14. King RB, Semik PE. Stroke caregiving: difficult times, resource use, and needs during the first 2 years. J Gerontol Nurs 2006 Apr;32(4):37-44. [doi: 10.3928/00989134-20060401-07] [Medline: 16615711]

15. Simon C, Kumar S, Kendrick T. Formal support of stroke survivors and their informal carers in the community: a cohort study. Health Soc Care Community 2008 Dec;16(6):582-592. [doi: 10.1111/j.1365-2524.2008.00782.x] [Medline: 18371168]

16. Measuring the family/friend caregiver experience in Ontario: pilot study results. Health System Performance Research Network (HSFPRN). URL: https://www.huntingtonsociety.ca/wp-content/uploads/2016/12/Caregiver-Study-Pilot-Results_HSFPRN-Final-Report.pdf [accessed 2021-08-15]

17. Taylor MG, Quesnel-Vallée A. The structural burden of caregiving: shared challenges in the United States and Canada. Gerontologist 2017 Feb;57(1):19-25. [doi: 10.1093/geront/gnw102] [Medline: 27521577]
18. Mo GY, Biss RK, Poole L, Stern B, Waite K, Murphy KJ. Technology use among family caregivers of people with dementia. Can J Aging 2021 Jun;40(2):331-343. [doi: 10.1017/S0714980820000949] [Medline: 32515318]

19. Ploeg J, Markle-Reid M, Valaitis R, McAiney C, Duggleby W, Bartholomew A, et al. Web-based interventions to improve mental health, caregiving outcomes, and general health for informal caregivers of adults with chronic conditions living in the community: rapid evidence review. J Med Internet Res 2017 Jul 28;19(7):e263 [FREE Full text] [doi: 10.2196/jmir.7564] [Medline: 28754652]

20. Sherifi D, Ali MU, Ploeg J, Markle-Reid M, Valaitis R, Bartholomew A, et al. Impact of internet-based interventions on caregiver mental health: systematic review and meta-analysis. J Med Internet Res 2018 Jul 03;20(7):e10668 [FREE Full text] [doi: 10.2196/jmir.6689] [Medline: 29970358]

21. Bashshur R, Shannon G, Krupinski E, Grigsby J. The taxonomy of telemedicine. Telemed J E Health 2011;17(6):484-494. [doi: 10.1089/tmj.2011.0103] [Medline: 21718114]

22. mHealth: new horizons for health through mobile technologies. World Health Organization. URL: https://www.who.int/goe/publications/goe_mhealth_web.pdf [accessed 2021-08-15]

23. Zulman DM, Piette JD, Jenchura EC, Asch SM, Rosland A. Facilitating out-of-home caregiving through health information technology: survey of informal caregivers' current practices, interests, and perceived barriers. J Med Internet Res 2013 Jul 10;15(7):e123 [FREE Full text] [doi: 10.2196/jmir.2472] [Medline: 23841987]

24. Grossman MR, Zak DK, Zelinski EM. Mobile apps for caregivers of older adults: quantitative content analysis. JMIR Mhealth Uhealth 2018 Jul 30;6(7):e162 [FREE Full text] [doi: 10.2196/mhealth.9345] [Medline: 30061093]

25. Young HM, Bell JF, Whitney RL, Ridberg RA, Reed SC, Vitaliano PP. Social determinants of health: unreported heterogeneity in systematic reviews of caregiver interventions. Gerontologist 2020 Feb 14;60(Suppl 1):S14-S28 [FREE Full text] [doi: 10.1093/geront/gnz148] [Medline: 32057083]

26. Sangrar R, Docherty-Skippen SM, Beattie K. Blended face-to-face and online/computer-based education approaches in chronic disease self-management: a critical interpretive synthesis. Patient Educ Couns 2019 Oct;102(10):1822-1832. [doi: 10.1016/j.pec.2019.05.009] [Medline: 31101427]

27. O'Neill J, Tabish H, Welch V, Petticrew M, Pottie K, Clarke M, et al. Applying an equity lens to interventions: using PROGRESS ensures consideration of socially stratifying factors to illuminate inequities in health. J Clin Epidemiol 2014 Jan;67(1):56-64. [doi: 10.1016/j.jclinepi.2013.08.005] [Medline: 24189091]

28. Page MJ, McKenzie JE, Bossuyt PM, Bouten I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Int J Surg 2021 Apr;88:105906. [doi: 10.1016/j.isujo.2021.105906] [Medline: 33789826]

29. Garnett A, Northwood M, Sangrar R, Ting J. Interventions to support caregivers of older adults: an equity-focused systematic review. PROSPERO. URL: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42021239584 [accessed 2021-08-15]

30. Dugas M, Gao GG, Agarwal R. Unpacking mHealth interventions: a systematic review of behavior change techniques used in randomized controlled trials assessing mHealth effectiveness. Digit Health 2020;6:2055207620905411 [FREE Full text] [doi: 10.1177/2055207620905411] [Medline: 32128233]

31. Mobile fact sheet. Pew Research Center. URL: https://www.pewresearch.org/internet/fact-sheet/mobile/ [accessed 2021-08-15]

32. Petrovic M, Gaggioli A. Digital mental health tools for caregivers of older adults—a scoping review. Front Public Health 2020;8:128 [FREE Full text] [doi: 10.3389/fpubh.2020.00128] [Medline: 32411643]

33. Rathnayake S, Moyle W, Jones C, Calleja P. mHealth applications as an educational and supportive resource for family carers of people with dementia: an integrative review. Dementia (London) 2019;18(7-8):3091-3112. [doi: 10.1177/1471301218768903] [Medline: 29631492]

34. Wasilewski MB, Stinson JN, Cameron JL. Web-based health interventions for family caregivers of elderly individuals: a scoping review. Int J Med Inform 2017 Jul;103:109-138. [doi: 10.1016/j.ijmedinf.2017.04.009] [Medline: 28550996]

35. Health Promotion, Inequalities and Young People’s Health A Systematic Review of Research. London: University of London; 2008.

36. Critical appraisal tools. JBI. URL: https://jbi.global/critical-appraisal-tools [accessed 2021-06-06]

37. Beentjes KM, Neal DP, Kerkhof YF, Broeder C, Moerijden ZD, Ettema TP, et al. Impact of the FindMyApps program on people with mild cognitive impairment or dementia and their caregivers: an exploratory pilot randomised controlled trial. Disabil Rehabil Assist Technol 2020 Nov 27;1-13. [doi: 10.1080/17438107.2020.1842918] [Medline: 33245000]

38. Callan JA, Siegle GJ, Abeke K, Black B, Martire L, Schulz R, et al. Feasibility of a pocket-PC based cognitive control intervention in dementia spousal caregivers. Aging Ment Health 2016 May 06;20(6):575-582 [FREE Full text] [doi: 10.1080/13607863.2015.1031635] [Medline: 25945597]

39. Lai R, Tensil M, Kurz A, Lautenschlager NT, Diehl-Schmid J. Perceived need and acceptability of an app to support activities of daily living in people with cognitive impairment and their carers: pilot survey study. JMI R Mhealth Uhealth 2020 Jul 31;8(7):e16928 [FREE Full text] [doi: 10.2196/16928] [Medline: 32735223]

40. Salin S, Laaksonen H. Bringing older informal caregivers and recipients to the digital age: experiences of using digital services. Technol Disability 2019 Oct 08;31(3):115-127. [doi: 10.3233/tad-190230]
41. Sourbeer K, Bankole A, Anderson M, Newbold T, Nama R, Belay M, et al. Assessing BESI mobile application usability for caregivers of persons with dementia. Gerontechnology 2018 Aug 10;17(2):102-112. [doi: 10.4017/gt.2018.17.2.004.00]

42. Watcharasamsap T, Tanlamai U, Lipikorn R. Innovative communication mechanism for the psychological well-being of caregivers and elderly with dementia in the context of Thailand. Int J Innov Creativity Change 2020;13(6):458-474 [FREE Full text]

43. Davis B, Nies M, Shehab M, Shenk D. Developing a pilot e-mobile app for dementia caregiver support: lessons learned. Online J Nurs Informatics 2014;18(1) [FREE Full text]

44. Lai FH, Yan EW, Yu KK, Tsui W, Chan DT, Yee BK. The protective impact of telemedicine on persons with dementia and their caregivers during the COVID-19 pandemic. Am J Geriatr Psychiatry 2020 Nov;28(11):1175-1184 [FREE Full text] [doi: 10.1016/j.jagp.2020.07.019] [Medline: 32873496]

45. Hastings SN, Mahanna EP, Berkowitz TS, Smith VA, Choate AL, Hughes JM, et al. Video-enhanced care management for medically complex older adults with cognitive impairment. J Am Geriatr Soc 2021 Jan;69(1):77-84 [FREE Full text] [doi: 10.1111/jgs.16189] [Medline: 32966603]

46. Kales HC, Gitlin LN, Stanislawski B, Myra Kim H, Marx K, Turnwald M, et al. Effect of the WeCareAdvisor™ on family caregiver outcomes in dementia: a pilot randomized controlled trial. BMC Geriatr 2018 May 10;18(1):113 [FREE Full text] [doi: 10.1186/s12877-018-0801-5] [Medline: 29747583]

47. Ptomey LT, Vidoni ED, Montenegro-Montenegro E, Thompson MA, Sherman JR, Gorczyca AM, et al. The feasibility of remotely delivered exercise session in adults with Alzheimer’s disease and their caregivers. J Aging Phys Act 2019 Sep 01;27(5):670-677 [FREE Full text] [doi: 10.1123/japa.2018-0298] [Medline: 30745664]

48. Quinn CC, Staub S, Barr E, Gruber-Baldini A. Mobile support for older adults and their caregivers: dyad usability study. JMIR Aging 2019 May 23;2(1):e12276 [FREE Full text] [doi: 10.2196/12276] [Medline: 31518271]

49. Garvelink MM, Agbadj TT, Freitas A, Bergeron L, Petitjean T, Dugas M, et al. Improving a web-based tool to support older adults to stay independent at home: qualitative study. JMIR Mhealth Uhealth 2020 Jul 22;8(7):e16979 [FREE Full text] [doi: 10.2196/16979] [Medline: 32412908]

50. Hughes JC, Banerjee T, Goodman G, Lawhorne L. A preliminary qualitative analysis on the feasibility of using gaming technology in caregiver assessment. J Technol Human Serv 2017 Jul 25;35(3):183-198. [doi: 10.1080/15228835.2017.1347153]

51. Killin LO, Russ TC, Svardh SK, Yoon Y, McKinstry B, Gibson G, et al. Digital Support Platform: a qualitative research study investigating the feasibility of an internet-based, postdiagnostic support platform for families living with dementia. BJM Open 2018 Apr 12;8(4):e020281 [FREE Full text] [doi: 10.1136/bmjopen-2017-020281] [Medline: 29654028]

52. Rathnayake S, Jones C, Calleja P, Moyle W. Family carers’ perspectives of managing activities of daily living and use of mHealth applications in dementia care: a qualitative study. J Clin Nurs 2019 Dec;28(23-24):4460-4470. [doi: 10.1111/jocn.15030] [Medline: 31408554]

53. Ruggiano N, Brown EL, Shaw S, Geldmacher D, Clarke P, Hristidis V, et al. The potential of information technology to navigate caregiving systems: perspectives from dementia caregivers. J Gerontol Soc Work 2017 Jul 25;60(5):423-432. [Medline: 28528352.2017.1347151]

54. Ryan AA, McCauley CO, Laird EA, Gibson A, Mulvenna MD, Bond R, et al. ‘There is still so much inside’: the impact of personalised reminiscence, facilitated by a tablet device, on people living with mild to moderate dementia and their family carers. Dementia (London) 2020 May;19(4):1131-1150. [doi: 10.1177/1471301219873793]

55. Span M, Smits C, Jukema J, Groen-van de Ven L, Janssen R, Vernooij-Dassen M, et al. An interactive web tool for facilitating shared decision-making in dementia-care networks: a field study. Front Aging Neurosci 2015;7:128 [FREE Full text] [doi: 10.3389/fnagi.2015.00128] [Medline: 26217221]

56. Banbury A, Parkinson L, Gordon S, Wood D. Implementing a peer-support programme by group videoconferencing for isolated carers of people with dementia. J Telemed Telecare 2019 Oct;25(9):572-577. [doi: 10.1177/1357633X19873793] [Medline: 31631761]

57. Breebaart H, Broese van Groenou M. A groupware tool to facilitate caregiving for home-dwelling frail older persons in the Netherlands: mixed-methods study. JMIR Aging 2018 Dec 07;1(2):e10697 [FREE Full text] [doi: 10.2196/10697] [Medline: 31518286]

58. Brown EL, Ruggiano N, Page TF, Roberts L, Hristidis V, Whiteman KL, et al. CareHeroes web and android™ apps for dementia caregivers: a feasibility study. Res Gerontol Nurs 2016;9(4):193-203 [FREE Full text] [doi: 10.3928/19404921-20160229-02] [Medline: 29977440]

59. Dam AE, Christie HL, Smeets CM, van Boxtel MP, Verhey FR, de Vugt ME. Process evaluation of a social support platform ‘Inlife’ for caregivers of people with dementia. Internet Interf 2019 Mar;15:18-27 [FREE Full text] [doi: 10.1016/invent.2018.09.002] [Medline: 30510911]

60. Sikder AT, Yang FC, Schafer R, Dowling GA, Traeger L, Jain FA. Mentalizing imagery therapy mobile app to enhance the mood of family dementia caregivers: feasibility and limited efficacy testing. JMIR Aging 2019 Mar 21;2(1):e12850 [FREE Full text] [doi: 10.2196/12850] [Medline: 31518275]
61. Costa Stutzel M, Filippo MP, Sztajnberg A, da Costa RM, Brites AD, da Motta LB, et al. Multi-part quality evaluation of a customized mobile application for monitoring elderly patients with functional loss and helping caregivers. BMC Med Inform Decis Mak 2019 Jul 22;19(1):140 [FREE Full text] [doi: 10.1186/s12911-019-0839-3] [Medline: 31331309]

62. Tyack C, Camic PM, Heron MJ, Hubert S. Viewing art on a tablet computer: a well-being intervention for people with dementia and their caregivers. J Appl Gerontol 2017 Jul;36(7):864-894. [doi: 10.1177/0733464815617287] [Medline: 26675353]

63. Davis NJ, Clark PC, Johnson TM, Wyman JF. Feasibility of Tele-Prompt: a tablet-based prompted voiding intervention to support informal caregivers of older adults with urinary incontinence. Geriatri Nurs 2020;41(4):411-420. [doi: 10.1016/gerinurse.2020.01.002] [Medline: 31987698]

64. Park E, Park H, Kim EK. The effect of a comprehensive mobile application program (CMAP) for family caregivers of home-dwelling patients with dementia: a preliminary research. Jpn J Nurs Sci 2020 Oct;17(4):e12343. [doi: 10.1111/jjns.12343] [Medline: 32363664]

65. Bédard M, Molloy DW, Squre L, Dubois S, Lever JA, O'Donnell M. The Zarit Burden Interview: a new short version and screening version. Gerontologist 2001 Oct;41(5):652-657. [doi: 10.1093/geront/41.5.652] [Medline: 11574710]

66. Kaye LW. Assessing the efficacy of a self-help support group program for older women. J Women Aging 1996 Feb;7(7):41-30. [doi: 10.1300/j074v07n04_03]

67. Bangor A, Kortum PT, Miller JT. An empirical evaluation of the system usability scale. Int J Human Comput Interact 2008 30;24(6):574-594. [doi: 10.1080/10447310802205776]

68. Anderson JG, Flatt JD, Jabson Tree JM, Gross AL, Rose KM. Characteristics of sexual and gender minority caregivers of people with dementia. J Aging Health 2021 Dec;33(10):838-851 [FREE Full text] [doi: 10.1177/08982643211014767] [Medline: 33998313]

69. Boehmmer U, Clark MA, Heeren TC, Showalter EA, Fredman L. Differences in caregiving outcomes and experiences by sexual orientation and gender identity. LGBT Health 2018;5(2):112-120. [doi: 10.1089/lgbt.2017.0144] [Medline: 29364755]

70. Schulz R, Eden J. Family caregiving roles and impacts. In: Families Caring for an Aging America. Washington, DC: The National Academies Press; 2016.

71. Veinot TC, Mitchell H, Ancker JS. Good intentions are not enough: how informatics interventions can worsen inequality. J Am Med Inform Assoc 2018 01;25(5):1080-1088. [doi: 10.1093/jamia/ocy052] [Medline: 29788380]

72. Cheasser AK, Keene Woods N, Smothers K, Rogers N. Health literacy and older adults: a systematic review. Gerontol Geriatr Med 2016;2:2333721416630492 [FREE Full text] [doi: 10.1177/2333721416630492] [Medline: 28138488]

73. Lindeman DA, Kim KK, Gladstone C, Apesoa-Varano EC. Technology and caregiving: emerging interventions and directions for research. Gerontologist 2020 Feb 14;60(1):S41-S49 [FREE Full text] [doi: 10.1093/geront/gnz178]

74. Caregivers & technology: what they want and need. AARP. URL: https://www.aarp.org/content/dam/aarp/research/surveys_statistics/ltc/2018/caregivers-technology-needs.pdf [accessed 2021-08-16]

75. Cosco TD, Firth J, Vahia I, Sixsmith A, Torous J. Mobilizing mHealth data collection in older adults: challenges and opportunities. JMIR Aging 2019 Mar 19;2(1):e10019 [FREE Full text] [doi: 10.2196/10019] [Medline: 31518253]

76. Sharma N, Chakrabarti S, Grover S. Gender differences in caregiving among family - caregivers of people with mental illnesses. World J Psychiatry 2016;6:22(6):7-17. [doi: 10.5498/wjp.v6.i1.7] [Medline: 27014594]

77. Dilworth-Anderson P, Brummett BH, Goodwin P, Williams SW, Williams RB, Siegel IC. Effect of race on cultural justifications for caregiving. J Gerontol B Psychol Sci Soc Sci 2005 Sep;60(5):S257-S262. [doi: 10.1093/geronb/60.5.s257] [Medline: 16131626]

78. Williams A, Sethi B, Duggleby W, Ploeg J, Markle-Reid M, Peacock S, et al. A Canadian qualitative study exploring the diversity of the experience of family caregivers of older adults with multiple chronic conditions using a social location perspective. Int J Equity Health 2016 Mar 02;15:40 [FREE Full text] [doi: 10.1186/s12939-016-0328-6] [Medline: 26936057]

79. Sidani S, Gurge S, Miranda J, Ford-Gilboe M, Varcoe C. Cultural adaptation and translation of measures: an integrated method. Res Nurs Health 2010 Apr;33(2):133-143. [doi: 10.1002/nur.20364] [Medline: 20069612]

80. Cristiano A, Musteața S, De Silvestri S, Bellandi V, Cervolo P, Cersari M, et al. Older adults' and clinicians' perspectives on a smart health platform for the aging population: design and evaluation study. JMIR Aging 2022 Feb 28;5(1):e29623 [FREE Full text] [doi: 10.2196/29623] [Medline: 35225818]

81. Portz JD, Ford KL, Elsbernd K, Knoepke CE, Flint K, Bekelman DB, et al. "I like the idea of it…but probably wouldn't use it" - health care provider perspectives on heart failure mHealth: qualitative study. JMIR Cardio 2020 Sep 04;4(1):e18101 [FREE Full text] [doi: 10.2196/18101] [Medline: 32885785]

82. Jaana M, Paré G. Comparison of mobile health technology use for self-tracking between older adults and the general adult population in Canada: cross-sectional survey. J Mhealth Uhealth 2020 Nov 27;8(11):e24718 [FREE Full text] [doi: 10.2196/24718] [Medline: 33104517]

83. Brewer LC, Fortuna KL, Jones C, Walker R, Hayes SN, Patten CA, et al. Back to the future: achieving health equity through health informatics and digital health. JMIR Mhealth Uhealth 2020 Jan 14;8(1):e14512 [FREE Full text] [doi: 10.2196/14512] [Medline: 31934874]
84. Ibrahim S, Sidani S. Strategies to recruit minority persons: a systematic review. J Immigr Minor Health 2014 Oct;16(5):882-888. [doi: 10.1007/s10903-013-9783-y] [Medline: 23338906]

85. Welch V, Petticrew M, Ueffing E, Benkhalti Jandu M, Brand K, Dhaliwal B, et al. Does consideration and assessment of effects on health equity affect the conclusions of systematic reviews? A methodology study. PLoS One 2012;7(3):e31360 [FREE Full text] [doi: 10.1371/journal.pone.0031360] [Medline: 22427804]

86. Furler J, Magin P, Pirotta M, van Driel M. Participant demographics reported in "Table 1" of randomised controlled trials: a case of "inverse evidence"? Int J Equity Health 2012 Mar 19;11:14 [FREE Full text] [doi: 10.1186/1475-9276-11-14] [Medline: 22429574]

87. Welch V, Petticrew M, Tugwell P, Moher D, O'Neil J, Waters E, PRISMA-Equity Bellagio group. PRISMA-Equity 2012 extension: reporting guidelines for systematic reviews with a focus on health equity. PLoS Med 2012;9(10):e1001333 [FREE Full text] [doi: 10.1371/journal.pmed.1001333] [Medline: 23222917]

**Abbreviations**

- **mHealth**: mobile health
- **PRISMA**: Preferred Reporting Items for Systematic Reviews and Meta-Analyses
- **PROGRESS-Plus**: place of residence, race, occupation, gender, religion, education, social capital, socioeconomic status–plus age, disability, and sexual orientation
- **PROSPERO**: International Prospective Register of Systematic Reviews

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