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An Evaluation of Mobile Applications for Improving Health in Older Adults: A Review of the Literature

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ABSTRACT: There are over one million mobile applications or "apps" available for use in improving health. One population that could potentially benefit from the use of mobile applications is the elderly. Choosing appropriate applications can be daunting, however, and there is a paucity of research identifying which applications are useful for elderly patients. The aim of this study is to perform a literature review regarding the available mobile applications for health and fitness and to provide health care providers with evidence-based information about other potentially useful and novel applications for their older patients.

In an attempt to address the need for identifying useful mobile applications for the elderly, I conducted a literature review on health and technology articles published within the last ten years. Search terms included *mobile app**, *smartphone app**, *elderly, older,* and *aged*. Eight articles are identified and discussed here that meet the inclusion criteria. Six of these articles reported effectiveness of the application, while all reported positive feedback from elderly users. Two of the studies were randomized controlled trials, and four were pilot or feasibility studies. Three notable apps that received positive feedback—*"Its LiFE"*, *"Heart Coach"*, and *"Stim' Art"*— were all supplemented by another form of technology and human interaction.

The sample sizes of these studies are small, and knowledge related to the effectiveness of these apps in older adults is limited; therefore, further research is necessary to evaluate the effectiveness of apps in improving the health of all patients.

KEYWORDS: older adults; mobile applications; health; technology; aged

INTRODUCTION

Today's college students have never lived in a world without mobile phones. These mobile devices touch virtually every part of our daily lives, a phenomenon that has grown significantly in recent years. In November of 2004, only 65% of American adults owned a mobile phone, but by May of 2013, the percentage of mobile phone owners increased to 91%, and this percentage has only continued to climb.[1]

The first cell phone debuted in 1973 as a large metal block. Cell phones evolved into the "flip phone" in 1989 and then devices that could access the Internet, emails, and even send/receive faxes.[2] By 2002, T-Mobile's "Sidekick" also had the groundbreaking capability of accepting mobile applications—programs downloaded onto the device that can add an unlimited number of new functions. This invention was the first commercially available mobile phone representing the modern definition of "smartphone."

By 2007, Apple Inc. unveiled the iPhone, a smartphone design that dominated the industry as the most commonly owned smartphone. This release was later followed by the development of Samsung Galaxy and HTC One smartphones, which run on a different operating system than the iPhone, known as Android.[2,3] There has been a significant increase in the use of smartphones. In 2013, only 56% of Americans had smartphones, but by 2017, 94% of 18-34 year olds and 42% of the 65+ population possessed a smartphone.[4,5] The invention and widespread use of smartphones has brought millions of people a technology that is virtually limitless. Smartphone users can now download mobile applications with thousands of different functions.

Between the App Store and Android Market—online stores geared towards iPhones and Android phones respectively—there are over two-million applications available for purchase. These applications can do anything from assisting people with budgeting their money and promoting health or simply playing games. Of the most frequently downloaded applications, 21% of them are associated with health and fitness.[6] For example, in Apple's App Store, of the top 50 highest rated Health & Fitness applications available, 22 of them assist with maintaining fitness and working out, 12 assist with maintaining proper nutrition, nine allow for tracking of bodily function (i.e., menstrual cycles, blood pressure, glycemic index), and seven assist with meditation

and mental calming.[7] These mobile applications offer significant opportunities to help provide new strategies for a plethora of medical issues affecting all age groups of patients.

One group that could benefit from mobile applications are older adults (age 65 and older). Mobile apps could potentially address the specific needs and limitation of older adults. For example, transportation may be an issue for older adults as they may lose their ability to drive due to chronic conditions, disability, lack of access to public transportation, and lack of caregivers.[8] Mobile apps may provide health information and access to practitioners when older adults are unable to travel to their provider. Health applications have the potential to provide older adults access to health interventions or self-management strategies that they can easily access from their home.

Some applications are designed specifically for older adults. The most common applications help older adults track bodily function (e.g.,"HeartWise" and "iBP"), monitor medications and dosage (e.g.,"Pillboxie" and "Pill Reminder Pro"), provide medical information (e.g.,"WebMD" and "Pocket Physio"), and offer generalized medical assistance (e.g.,"Motion Doctor" and "My Medical").[9-11] Despite the availability of health applications for older adults, recommendations on available applications and their effectiveness are anecdotal. Anyone who owns a smartphone can search and download applications based on their need. Nevertheless, older adults may require further guidance due to the overwhelming number of available applications and a lack of skill navigating through mobile technology.

Thus, despite the widespread availability of health-related applications, there is a paucity of evidence to support their usefulness and effectiveness. Although there has been some investigation of mobile applications use specifically for preventative care and health-related conditions[12], there is minimal literature discussing their use in older populations. This gap in research makes it difficult for healthcare providers to suggest specific applications to their older patients. Therefore, this literature review will examine the effectiveness of available mobile health applications in order to provide health care providers with evidence-based information about potential useful applications for their older patients, which could ultimately lead to overall improved healthcare for the elderly.

METHODS

A literature review was performed using the following databases: CINAHL, MEDLINE, PsychINFO, Cochrane Database of Systematic Reviews, IEE Xplore, and Inspec. These databases were selected for their ability to provide literature examining mobile applications from both a healthcare and technology perspective. Key words utilized included *mobile app*, smartphone app*, elderly, older,* and *aged*. The term app* was truncated to capture all variations of the word "application." The studies published between the years 2007 to 2017 were selected for further review.

Next, individual abstracts were evaluated based on the inclusion criteria, such as any research article testing mobile application effectiveness, any population containing at least 50% of older adult participants (aged 65+), and any studying pertaining to the use of a mobile application that promoted health and well-being. Articles were then analyzed based on the purpose of the study, technology used in the study, the design of the study, health issue to which the technology pertained, demographic information of the participants, results/outcomes of the study, and any challenges that were met. Finally, selected data were analyzed to focus on common themes to categorize and synthesize information.

FINDINGS

The initial search yielded 201 articles (Figure 1), with each abstract being reviewed. One-hundred and nineteen were discarded for not meeting any of the inclusion criteria. Twenty-seven were excluded because the application analyzed did not attempt to benefit the health of its user, five were not research studies, three exhibited no testing of the application within the desired age group (65+), three did not exhibit any testing of the application at all, one did not pertain to mobile technology, and 13 were inaccessible due to removal from the journal. Thirty were retained for the entire article to be read and analyzed. Upon this analysis, 22 more were discarded. Eight did not exhibit any testing of the application, five of the applications being tested did not promote the health of its user, and nine did not meet my inclusion criteria regarding age of participants. This left eight articles for review. Five of these clearly met inclusion criteria regarding age. Three more were retained because their mean age of participants approached 60, so they contained a significant number of participants aged 65 and older.

The eight articles were categorized depending on the specific purpose of the technology. Four focused on improving the lives of patients living with chronic diseases, two aimed to benefit the mental health of its users, and two focused on improving general well-being.

Chronic Diseases

Of the articles dealing with applications that benefit patients with chronic diseases, two were pilot studies, one was a randomized controlled trial, and a fourth was a feasibility study. The apps in both pilot studies aimed to improve self-management of Type 2 diabetes. The randomized controlled trial assessed a text-messaging intervention to promote medication adherence. The feasibility study evaluated an app as a possible adjunct to cardiac rehabilitation.

Verway and colleagues[13] conducted a pilot study to examine the performance, acceptance, and user satisfaction of the "its Life" tool. The tool was designed to stimulate physical activity in patients (N=20) with COPD or type II diabetes. Participants had a mean age of 60 years (range 41-84). Only 30% had previous experience with smartphones. Participants received an accelerometer, smartphone for the app, a data subscription, and a web application. "its Life" was paired with goal and activity planning and several consultations with a nurse over a three-month period. Overall, the majority (n=12) of participants believed the intervention was useful and the rest were neutral. Mean physical activity increased significantly (p=0.02) over time. Quality of life showed significant improvement (p=0.04) over time and ongoing consultations received positive feedback. Reported challenges included technological problems which led to participants dropping out of the study, decreased adherence, and missing data. Excessive time was also required to teach participants how to use the app, and some participants reported that the lack of reward for effort was disappointing.

Another pilot study by Nes and Van Dulmen[14] in Norway developed and tested the feasibility of a web-based intervention: the "Few Touch Application" to improve self-management of diabetes. The intervention delivered "Acceptance and Commitment Therapy," which sought to improve participants' commitment to live a healthy lifestyle. The study's 15 participants had a mean age of 59.6 years (range: 46-71). Participants were provided an online website account allowing the app to connect to a secure server, individualized written feedback, a

smartphone with the "Few Touch Application" installed, and audio files with mindfulness and relaxation exercises. Participants were asked to self-report blood glucose levels using a glucose meter synced with the app and fill out three daily diary entries in the app clarifying their values and commitment to behavioral change. The majority of participants reported the intervention as supportive (n=11), meaningful (n=10), and motivational (n=10). Many participants also reported that the intervention motivated them to follow their diet plan (n=10), check their blood sugar level (n=9), and take medications properly (n=10). Reported challenges included the attrition of four of the 15 participants due to their concern that participation in the study would be too much of a time commitment. Other challenges included repeated system breakdowns and failure of the application to connect to the Internet. It was also reported that carrying around the borrowed smartphone was a nuisance.

Park and colleagues[15] conducted a randomized controlled trial to examine the efficacy of a mobile health intervention using text-messaging, via the standard issue "text messaging" application on the participants personal smartphones to promote medication adherence in patients with a history of coronary heart disease. Participants (N=90) had a mean age of 59.2 with a range of 35-83 years. The study involved dividing participants into three groups: one group received text messaging reminders to take medication along with educational text messages informing them about coronary heart disease, the second group received only educational text messages, and the third group received no text messages. Over 30 days, text messaging reminders were sent at a time chosen by the participant to be consistent with their personal medication schedule. Participants were also provided with an electronic pill bottle that recorded when it was opened to track their medication schedule. The percentage of correct doses taken (p=0.02), number of doses taken (p=0.01), and prescribed doses taken on schedule (p=0.01) were all higher in participants who received text messaging reminders. The majority of participants agreed that they were satisfied with receiving text messages about health (82%), felt that receiving text messages helped them take their medication (71%), and that receiving text messages made them feel like somebody cared (75%). However, improper usage on the part of the patient led to some unanalyzable data, and many patients were unfamiliar with how to use text messaging and needed to be instructed.

Forman and LaFond[16] assessed the feasibility of an app called "Heart Coach" as a possible adjunct to clinic-based cardiac rehabilitation. The 26 participants had a mean age of 59 and an age range of 43-76. Participants downloaded the app and used it while enrolled in traditional clinic-based cardiac rehabilitation. The app included a "task list" that needed to be completed by users, such as engaging in moderate exercise, taking medications, and watching educational videos. Over 30 days, participants used the app daily while their activity was monitored by cardiac rehabilitation providers. Eighty-three percent of participants reported an overall positive experience, 93% reported the application helped them adhere to rehabilitation activities, and 71% reported it improved the quality of their rehabilitation visits.

Cognitive Health

Two articles evaluated apps that sought to improve cognitive functioning and attention in older adults. Both analyzed a specific mobile application. In a French pilot study, Yasini and Marchand[17] evaluated the adoption of an application called "Stim'Art" for improving cognitive function in older adults. The 15 participants (ages of 79-88) were provided with a mobile device with the app preloaded onto it. This app contained *serious games* aimed to improve memory and brain training where each level of the game becomes progressively more difficult. Over the study's six-month duration, participants chose when they used the app and researchers recorded the time spent by participants playing the games and the level of difficulty on which they played. Researchers also calculated the perceived well-being of participants through a survey on well-being, which was prompted whenever participants tried to quit using the app. Perceived well-being was measured on a six-point scale. Over the course of the study, time spent using the app per day by participants significantly improved ($p < 7 \times 10^{-4}$). Number of game launches per day improved ($p < 7 \times 10^{-4}$). The success rate, as determined by an increase in the level of difficulty, showed significant improvement ($p < 6 \times 10^{-4}$). Also, all participants showed an increase in their perceived well-being score ($p < 0.001$).

In a descriptive mixed-methods study, Hill and colleagues[18] assessed the feasibility of an "Attention Training Application" for older adults living in the community. The goal was to obtain feedback for future development of the technology. This study included nine participants, in which six were urban dwelling (mean age of 84; range of 79-96 years) and three were from rural

communities (mean age of 68; range of 64-72). The application provided cognitive training (recall) using visual and auditory stimuli either alone or simultaneously. The app was designed like a game and displayed various icons if the participant answers questions correctly or incorrectly. Correct responses yielded positive feedback in the form of a green check icon and pleasant audio, whereas incorrect responses yielded negative feedback in the form of a red x and abrupt audio. Analysis showed the app was viewed favorably and rated highly on a 0 to 10 scale in likability (M=8.5, SD=1.6) and interest (M=8.8, SD=2.3). On the same scale, it was also rated moderately easy to use (M=6.4, SD=2.6, Range: 2-10). Participants found the negative feedback provided from the game distracting and frustrating but found the positive feedback to be a successful motivator. Participants also reported that they could see how improvements gained from this application could be relevant to daily tasks. Nevertheless, despite reporting being relatively comfortable with technology (7.1 on a 0 to 10 scale), participants had difficulty learning how to use the touch-screen on the mobile device, felt that they needed more time to practice, and reported they did not know of many other older adults they could recommend the intervention to.

General Well Being

One randomized controlled trial and one descriptive small-scale user testing study examined apps for general well-being of the user. The randomized controlled trial assessed the efficacy of text messages in improving exercise in older adults, and the user-testing study evaluated an app designed to assist with fall prevention in hospitalized users.

In an Australian randomized controlled trial, Müller and colleagues[19] examined the effects of a text messaging intervention on increasing exercise frequency for older adults. This intervention was done through the standard issued text-messaging application on smartphones. Participants (N=43) had a mean age of 63 with a range of 55-70 and were randomized into two groups, and both the intervention (n=22) and control (n=21) group were provided with an exercise booklet with instructions to use it as they pleased for exercise examples. The intervention group participants were also sent 60 text messages over the twelve-week study. These text messages instructed participants to exercise and provided positive feedback in the form of praise. Participants in the intervention group exercised more frequently per week (M=3.74, SD=1.34)

compared to the control group (M=2.54, SD=1.85). Both groups reported being satisfied with the exercise program and that the intervention improved their fitness and health, but the effects of the intervention were absent after 24-weeks as reported by a follow-up interview.

Tzeng and colleagues[20] assessed the feasibility of a smartphone app, "I Engaging", in a descriptive, small-scale user testing study. This app was designed specifically for older adults of ages 65+ to actively engage them to prevent falls during their hospital stay. Twenty-three participants with a mean age of 80 and range of 65-90 were recruited from in-patient hospitals (n=12) and elderly living communities (n=8). Participants were provided with a smart tablet (iPad) with the app pre-downloaded. The app first provided a fall risk assessment, patient selected personalized methods to help reduce fall risk as identified in the assessment, and an optional, printable fall prevention plan. Patients had the option to keep the tablet by their bed or somewhere else in the room. The software was reported easy to use (M=1.71, SD=0.46), effective, and practical. Hospital patients reported they felt it gave them a voice. Community living participants enjoyed the printed fall prevention plan but did not want to keep the tablet beside their bed. Health care providers also exhibited worry that the patients needed more instruction in using the app.

In summary, there are many similar characteristics among the apps studied (Figure 2). Most of these studies relied on small sample sizes. The most common characteristics were positive feedback from users, reported effectiveness of the application, and a need for further teaching among users. All apps which included personalization capability, as well as those that acted as an adjunct to another therapy, reported effectiveness and positive feedback from users. Positive feedback was also reported in all apps that utilized text messaging and those that included supplemental human-human interaction. For those studies in which additional teaching was necessary for users, all of them reported positive feedback from participants and the majority reported effectiveness of the application.

DISCUSSION

The aim of this literature review was to survey the effectiveness of available mobile applications for health and fitness and to provide health care providers with evidence-based information about other potentially useful applications for their older patients. Despite a

large variety of available mobile applications, there is minimal evidence about the effectiveness of these apps, and there is even less evidence examining apps designed specifically for an older population. Online app stores contain thousands of health improvement apps, but only a small fraction have been studied for effectiveness. In addition, the literature that is available for these apps does not consistently evaluate their effectiveness as a health improvement tool. The great majority of literature comes in the form of pilot studies and feasibility studies with small sample populations. Although these investigations do establish the potential of these applications as health interventions, there is an insignificant number of randomized controlled trials. This lack of evidence hinders the ability of nurses and other healthcare professionals to recommend use of these apps.

On a positive note, those studies that have evaluated specific mobile applications report positive feedback from users. They are frequently reported as easy-to-use, supportive, helpful and practical. This encouraging data from these small studies demonstrates that these apps might be beneficial to patients, but an increase in the assessment of app efficacy and larger samples are necessary before they can be readily recommended.

Two notable apps that reported positive feedback were "It's LiFe" and "Stim Art". Similar characteristics among these apps were supplementing of the app with additional human-human interaction and a component of personalization. In these two studies, participants used the app on their own at home, but the intervention also included personalized communication with a personal health coach or researcher. Personalization of the app included having reminders sent at specific times best suited for the user, setting individualized goals, and interventions that altered their level of difficulty or activity specifically for the user. Several studies were ambiguous as to whether the app could stand alone. The "Heart Coach" and "I Engaging" apps were used in conjunction with rehabilitation and other interventions, so there was no comparison of efficacy between use of the app in addition to other interventions and use of the app by itself. Although these studies reported positive results, it is unclear whether it is the app itself that effectively improves health or the combination with other treatments, such as cardiac rehabilitation or discussing goals with a health care provide.

One complaint about "Its Life" was the lack of reward for the effort users must put in. Two of the studied

applications provided rewards to users in the form of positive reinforcement. In the "Attention Training Application" this reinforcement manifested as a green check mark being displayed on the screen and pleasant auditory stimuli when users answered a question correctly. In Müller's examination of text messaging as a means to increase exercise frequency in older adults, positive reinforcement came in the form of personalized praise for attaining the user's goals. Both of these studies also reported positive feedback from users, thus positive reinforcement has been shown to correlate with user acceptance of the application.

Several difficulties were identified during this investigation. While there is some literature assessing the use of mobile apps in older adults, they are still a substantially underrepresented age group. Many studies include older adults as participants but not the primary demographic. This underrepresentation limits our ability to generalize findings to older adults. Common problems seen with older adults as participants may explain this lack of evidence. Many older participants do not own or have never used a smart phone. Thus, researchers commonly had to provide participants with the necessary devices. Older adults' lack of technological proficiency also led to extra time being spent teaching participants how to use the apps. Yet apps that required additional teaching still reported effectiveness. Other problems that arose in several studies were technical problems with the apps that created some frustration in older participants.[8,9] However, both studies which reported technical problems also reported effectiveness and positive feedback from users. Shortcomings of new technology and the extra effort necessary to use it will not overcome older adults' desire to better themselves and stay connected to the world.

In summary, the feasibility of mobile apps in improving the health of older adults is supported by several feasibility and pilot studies. Nevertheless, due to their small sample size and the lack of randomized controlled trials investigating this topic, the degree of their effectiveness is still unknown. Personalization capabilities and conjunction with other interventions have been identified as positively correlated characteristics to efficacy. The use of positive reinforcement is related to positive feedback from users. Difficulties with apps, such as technical problems and the need for further teaching, do not impede their utilization by older adults, but there is still insufficient evidence to support recommendations of apps for evidence-based practice.
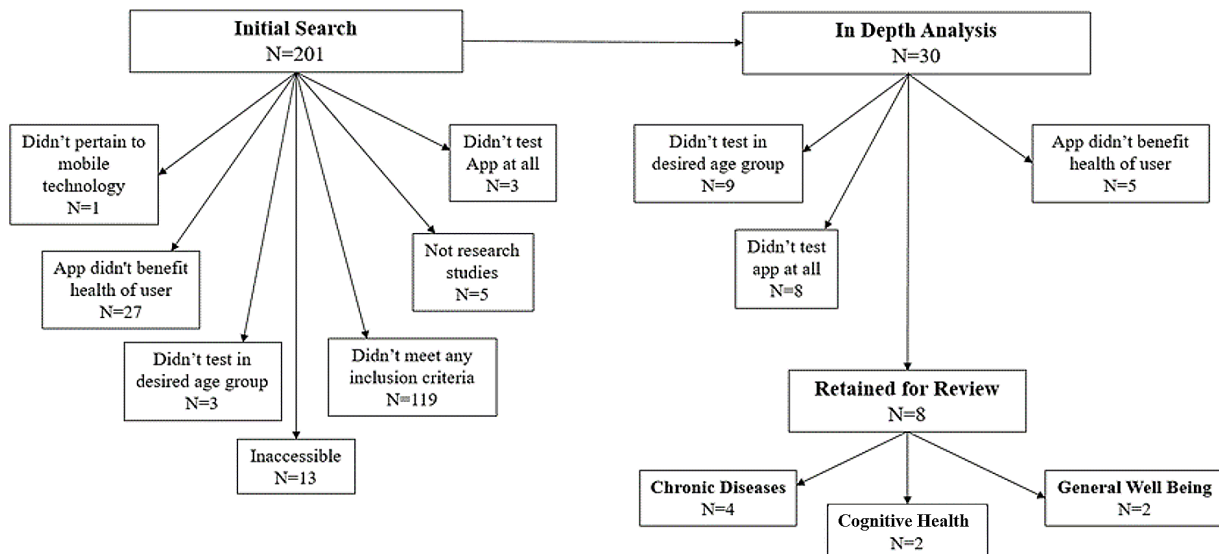
Figure 1. Results and Final Categories

Initial Search N=201 → In Depth Analysis N=30

From Initial Search N=201:
- Didn't pertain to mobile technology N=1
- App didn't benefit health of user N=27
- Didn't test in desired age group N=3
- Inaccessible N=13
- Didn't meet any inclusion criteria N=119
- Not research studies N=5
- Didn't test App at all N=3

From In Depth Analysis N=30:
- Didn't test in desired age group N=9
- Didn't test app at all N=8
- App didn't benefit health of user N=5
- Retained for Review N=8
  - Chronic Diseases N=4
  - Cognitive Health N=2
  - General Well Being N=2

Figure 2. Summary of Findings

Author of Study	Type of Study	App Name	Category	Application Characteristics								
				Reported Effective	Used Reward/ Positive Reinforcement	Teaching Required for Users	Positive Feedback from Users	Personalization Capability	Adjunct to Another Therapy	Additional human–human interaction	Use of Text Messaging	Technical Problems
Verway	Pilot Study	Its Life	Chronic Disease	✓		✓	✓	✓		✓		✓
Nes & Van Dulmen	Pilot Study	Few Touch	Chronic Disease	✓			✓	✓				✓
Park	RCT	N/A	Chronic Disease	✓		✓					✓	
Forman & Lafond	Feasibility Study	Heart Coach	Chronic Disease	✓			✓		✓			
Yasini & Marchand	Pilot Study	Stim' Art	Cognitive Health	✓						✓		
Hill	Feasibility Study	Attention Training	Cognitive Health		✓	✓	✓					
Müller	RCT	N/A	General Well Being	✓	✓		✓				✓	
Tzeng	User testing	I Engaging	General Well Being	✓		✓	✓	✓	✓	✓		

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