

# Engaging older adults to inform diabetes medication adherence mobile application selection

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**Background:** Medication nonadherence is a significant health concern that disproportionately affects older adults. Aging is often associated with comorbidities including diabetes and more complex drug regimens that can impact compliance.

**Objectives:** To explore smartphone use among older adults with diabetes to evaluate potential medication adherence application preferences.

**Methods:** This case report describes a series of stakeholder-engaged discussions with 11 older adults ages 60 years and older and 4 health care providers (HCPs), from a rural and small metropolitan community, in the southeastern United States. The Technology Acceptance Model led a conversation guide.

**Results:** Older adults had smartphone devices. When considering use of the 2 applications, older adults and HCPs indicated preference for the Medisafe application.

**Conclusions:** On the basis of advice of an older adult and HCP stakeholder sample, plans are underway to select a medication adherence application for future research.

**Keywords:** Stakeholder engagement, Medication nonadherence, Older adult, Diabetes, Technology, Smartphone, Computer

Poor medication adherence (MA) is a significant public health problem in the United States that disproportionately affects older adults resulting in negative outcomes including falls, cognitive impairment, and increased comorbidities<sup>[1–4]</sup>. Medication non-adherence (intentional and unintentional) for chronic conditions occur as often as 50% of the time in older adults and may result in significant morbidity and an additional US\$300 billion of costly use of health services for drug interactions and side effects<sup>[5]</sup>.

One major chronic condition increasing in older adults is diabetes<sup>[6]</sup>. Currently affecting 415 million people, diabetes is anticipated to impact 642 million people globally by 2040 and often requires a self-management approach, including nutrition, physical activity, weight management, and medications<sup>[7]</sup>. US older adults diabetes prevalence is estimated between 22% and 33%, depending on diagnostic criteria used<sup>[8]</sup>. MA is a challenge for many older adults with diabetes, as those who are older face more complex medication regimens adding to successful self-

management burdens<sup>[3,9,10]</sup>. Technology-enabled diabetes self-management including mobile health applications (app) has been explored to foster 1-way and 2-way communication between the patient and health care provider(s) (HCPs) and offer education to improve patient outcomes<sup>[11–14]</sup>. However, their influence on enhancing MA for older adults remains largely unexplored.

With rapid advances in smartphone technology, there are fewer limitations for older adults to adopt mobile devices. Approximately 77% of American adults report access to smartphones in all socioeconomic groups and ethnicities<sup>[15]</sup>. There have been several successful interventions using apps for adult MA in chronic conditions such as atrial fibrillation, diabetes, and heart failure<sup>[16–18]</sup>. However, there are limited data on app use for older adult medication management.

The Technology Acceptance Model (TAM) has been proposed to explain technology acceptance behavior including Perceived Use (PU) and Perceived Ease of Use (PEOU)<sup>[19–21]</sup>. PU is defined as the prospective user's subjective belief that a particular device will increase their performance<sup>[19,20]</sup>. PEOU is defined as the degree to which a person believes that using a particular device will be free from effort<sup>[19,20]</sup>.

## Design and methods

This case report (1) describes the process of stakeholder engagement for further intervention development, (2) presents results of informal stakeholder discussions, and (3) discusses stakeholder recommendations for a technology-enabled diabetes self-management to improve MA smartphone app. A stakeholder was defined as, “an individual [or group] who is responsible for or affected by health- or healthcare-related decisions that can be informed by [research] evidence”<sup>[22]</sup>. Engagement of stakeholder perspectives facilitates shared relationships that can result in long-term partnerships<sup>[23]</sup>.

Community members and clinical providers were recruited as stakeholders to determine interest for an older adult-focused intervention to enhance diabetes MA through informal discussions in the summer

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of 2017. Potential older adult stakeholders were approached in 2 communities, 1 rural community located in the Appalachian Mountains, and a small metropolitan city ~30 miles away. Older adults were included if they: (1) had self-reported diabetes, (2) were currently taking diabetes medication(s), (3) were age 60 years and older, and (4) spoke English. HCPs were included if they self-reported having older adult caregiving experience and self-reported diabetes knowledge. We excluded HCP who were not actively involved in current practice or practice-related service. Eighteen older adults were approached at a local library and/or a community agency in the rural setting; nine agreed and participated. Five older adults were approached in the metropolitan setting; 2 agreed and participated. Four HCP who provide health care services to older adults were approached (3 in the rural setting, 1 in the metropolitan setting) and participated.

The OnTimeRx and Medisafe app were shown to stakeholders (Fig. 1)<sup>[24-27]</sup>. The OnTimeRx is a mobile reminder app for iOS and Android phones, designed by a pharmacist that delivers reminders by Short Message Service (SMS), email, or phone<sup>[24]</sup>. The Medisafe smartphone platform and application operates on an iOS or Android mobile system by providing medication reminders<sup>[25,28]</sup>. Medications can be manually uploaded or auto-populated from the health record<sup>[24,25]</sup>. The first author demonstrated apps to stakeholders, and provided time for app use. For convenience, apps were downloaded on one iPhone for demonstration. Questions focused on digital technology ownership and usage for computer and/or smartphone (Table 1). TAM, PU, and PEOU, factors supporting each question are included in Table 1. Discussions were held at a convenient time and place for stakeholders in a private room at a local library, or community center.

The questionnaire was discussed with each stakeholder. Then, each app was demonstrated including how to add a medication, add dose and administration time(s), how to review patient education, and how to add a caregiver reminder. Stakeholders were offered the opportunity to add a medication using each app. Older adult conversations lasted ~30 minutes, and HCP conversations lasted ~15 minutes.

**Table 1**

**Digital technology ownership and usage questions with Technology Acceptance Model factors.**

	<b>Technology Acceptance Model</b>
Digital technology ownership questions	
Do you have a smartphone? If so, what type (iPhone or Android)	PEOU, PU
Do you use a computer, laptop, iPad?	PEOU, PU
Digital technology usage questions	
Do you use a mobile phone?	PEOU, PU
Do you use the internet via smartphone?	PEOU, PU
Do you use the internet via computer? If so, where (home, library, friend or family home, etc.)	PEOU, PU
Do you download apps, health apps, medication adherence apps?	ATT

ATT indicates Attitude Toward Using; PEOU, Perceived Ease of Use; PU, Perceived Use.

to add a medication using each app. Older adult conversations lasted ~30 minutes, and HCP conversations lasted ~15 minutes.

**Results**

**Sample**

The stakeholder feedback summary is included in Table 2. Older adult stakeholder were 73% (n=11) older adults (female=3, male=8) and mean age of 70 years (SD=5.75). Overall, older adults found the concept of technology for medication-taking appealing (64%, 7/11) and HCP (100%, 4/4). Older adults owned a cell phone (82%, 9/11), most owned a smartphone, and regularly used it (82%, 9/11). Most reported they did not actively use apps (58%, 7/12), and Internet access or data availability for smartphone or computer use was reported as inconsistent (40%, 6/15). Overall, individuals shared a preference for an app with larger, clearly visible font (ie, screen colors) (73%, 11/15). Older adults had smartphone devices, but not all reported data support for apps (75%, 6/8).

The total number of HCPs was 4; with 3 Registered Nurses and 1 nutritionist (3 from the rural setting, 1 from the metropolitan setting). All HCPs owned a smartphone, regularly used it (100%, 4/4), and reported active app use (75%, 3/4). HCPs in the rural community discussed inconsistent smartphone or computer Internet access and data availability for residents (75%, 3/4). All HCPs discussed older adults would need a user-friendly set-up and visible screen.

**Smartphone availability and use**

Overall, older adult stakeholders were familiar with smartphones. Many individuals stated that smartphone use was convenient and provided timely communication. Among older adults, 7 owned iPhones and 2 owned Android, 2 did not own a smartphone, but had used a cellular phone. All HCPs owned a cellular phone (2 iPhones and 2 Android).

**Limited or no current app usage**

Most individual stakeholders discussed limited app use (eg, health, finance apps). A few individuals were unfamiliar with apps. No stakeholder currently used an app for medication reminders. At the beginning of informal conversation, older adults seemed reluctant to use an app, but were comfortable seeing a demonstration.



**Figure 1.** OnTimeRx and Medisafe applications<sup>[26,27]</sup>.

**Table 2**  
**Stakeholder feedback summary guided by Technology Acceptance Model technology ownership and usage.**

Summary of Field Notes		
Older adult/stakeholder description	OnTimeRx: free app; downloaded the app on my iPhone and showed both apps to older adults and stakeholders	Medisafe: free app; downloaded the app on my iPhone and showed both apps to older adults and stakeholders
001: Age 67, uses an iPhone, and does not use apps	Liked the menu option and able to navigate settings. Commented about blue font (blue-on-blue difficult to see)	Preferred Medisafe view of morning, afternoon, evening and night. Liked medicine cabinet window. Able to add medication. Felt font was small
002: Retired nurse, uses an Android phone and some health apps	Liked both apps. Commented about blue-on-blue font and possible challenges for older adults	Preferred Medisafe app. Felt set-up was easier to follow and more like a pill box and medicine cabinet, so more user-friendly terminology for an older adult
003: Age 73, uses an iPhone, and does not actively use apps, but has downloaded health apps due to health issues	Preferred for navigation to be demonstrated, rather than use app. Stated font small and difficult to see	No preference for either app, preferred navigation to be demonstrated. Stated font small and difficult to see
004: Nutritionist, familiar with apps, particularly health apps	Commented on blue and light blue font. Otherwise felt this app was user-friendly and supportive	Preferred Medisafe app, liked the display settings and terminology used. Felt older adults would be able to add medications and understand directions
005: Age 66, does not own an iPhone, but has used cell phones	Unable to navigate apps, liked demonstration of app, stated blue font difficult to see	Unable to navigate apps, liked demonstration of app and preferred Medisafe app, liked set-up like medicine cabinet (ultimately stated neither app would be used)
006: Age 68, uses an Android, and uses some apps primarily for banking	Felt the app was a good idea, found blue font difficult to see on some screens, able to add medication and navigate menu "easily"	Liked both apps, found menu user-friendly and instructions easy to follow. This app was easier to see
007: Age 72, uses an iPhone, and has used health apps for fitness tracking	Able to navigate app and add medication, liked both apps. Found app easy to use	Felt either app would be equally helpful. Liked how there were instructions for how to add a medication and a place for a pill box
008: Age 74, uses an iPhone, and does not use apps	Interested in watching demonstration, stated not interesting in using apps, felt font size too small	Interested in watching demonstration, stated not interesting in using apps, preferred Medisafe app although stated not interested or able to use either app
009: Age 78, does not use a SmartPhone	Needed instructions for each step of using app, interested in having a smartphone but has limited access to cell phone signal and internet (lives in a remote area). Currently, goes to the library for computer use and has a land line. Preferred to watch demonstration of apps. Felt font was small and difficult to see	Preferred to watch demonstration of apps. Felt font was small and difficult to see
010: Nurse (CNE), uses an iPhone, and health apps	Discussed that many older adults had limited access (both cell phone and internet). Many used cell phones for emergency. Shared blue-on-blue font could be a challenge for older adults, app features supportive for navigation and adding medications	Liked Medisafe navigation set-up like pill box and medicine cabinet, felt this would be a "comfort zone" for older adults
011: Age 62, uses Android, iPhone in the past, familiar with apps but does not use	Interested in finding ways to remember, found apps user-friendly, able to add medications and navigate menu, liked "look," no preference, felt both apps could help	Liked both apps, able to navigate menu and add medication, liked instructions and how Medisafe provided updates
012: Age 61, uses iPhone, no apps at this time, but has downloaded banking apps	Able to navigate app and add medication. Commented on blue font, feeling the light blue font with white highlight was sometimes difficult to see	Preferred Medisafe app, feeling the bold colors were easier to see and app instructions were clear
013: Age 70, uses iPhone, unfamiliar with apps	Currently attending diabetes management classes and recently completed a diabetes medication management course. Keeps a written calendar log and thinks an app could be helpful	Found app helpful and able to add medication, follow instructions, liked menu options
014: Age 68, uses iPhone and Android in the past, familiar with health apps	Able to navigate app and add medication, found app user-friendly and liked both apps	Liked both apps and instructions for adding medications, felt reminder alarms could really help
015: Nurse, uses Android, iPhone in the past, and apps, including health apps	Able to navigate app and add medication, liked both apps and felt either app would help remind—especially with alarms and customizable 2nd alarms	Liked both apps and instructions for adding medications, felt reminder alarms could really help
	Felt both apps were user-friendly and had good instructions for use, wondered about font size for older adults as cell phones were small devices	Felt both apps were user-friendly and had good instructions for use, wondered about font size for older adults as cell phones were small devices

Several older adults shared they were unsure how to add an app, but were willing to try.

**Inconsistent Internet access or data**

Among individual stakeholders, both older adults and HCP described inconsistent access to a cellular signal for smartphone usage and/or limited data plans. Further, stakeholders in the rural

community expressed limited access to Internet due to a lack of cell towers and reception at their home.

**App preference**

The majority of older adult stakeholders discussed difficulty visualizing the smartphone screen. There were several comments about the OnTimeRx app "blue-on-blue" font color, small font size, and difficulty seeing words. Older adults expressed a preference for the

Medisafe app due to labeling of screens (eg, “like my medicine cabinet”). They were often able to navigate with assistance, yet several mentioned needing assistance (eg, “I need help”).

HCP stakeholders shared feedback about older adults, particularly related to visual acuity and suggested an app that has a clear font. HCP felt that a larger font size would benefit older adults, especially on main menus. HCP stakeholders felt older adults would have more difficulty seeing the OnTimeRx smartphone screen as compared with the Medisafe app.

## Discussion

The use of apps has been supported in other populations with diabetes as an adjunct for reminders about medication-taking behaviors and for improved<sup>[17,29]</sup>. Older adult perspectives and preferences are important considerations for technology-enabled adherence apps. In this case report, older adults with diabetes and HCPs reported how they used technology such as a smartphone and computer for technology-assisted apps. Older adults had smartphone devices, but some did not have data plans to support apps, and had app preference for a smartphone screen with visible font size. These findings demonstrate the importance of considering qualities that favor the aging individual such as font size, screen colors, and instructions as an app. These factors will be considered for a future intervention.

While there are a large number of diabetes apps, there is inconsistency regarding app quality, and number of functions. In addition, there is a lack of certification for apps as a medical product, although some apps are linked to an FDA approved external measurement device<sup>[30]</sup>.

An extensive number of smartphone apps are designed to promote MA; however, for many of those apps, significant evidence for positive behavioral change has not been demonstrated<sup>[31]</sup>. Methods to determine appropriate interventions including stakeholder engagement can inform the research question and intervention<sup>[32]</sup>. In this case report, the information obtained from older adults and providers will inform future app selection. Use of MA apps warrants investigation in future studies with older adults.

## Limitations

There were several limitations to this case report. There were no formal interviews or recordings, which resulted in anecdotal feedback and comments that are insightful, yet are a small sample of comments. Although the findings cannot be generalized, the results can provide insight for future intervention development. A power analysis was not conducted due to this study being a case report of a convenience sample of older adults. In future opportunities to discuss MA apps with the community of interest, the investigators may focus particularly on the demonstration capacity and interactivity of apps while providing more time for older adults to have “hands-on” opportunities to learn how to use the apps.

## Conclusions

Tailoring strategies to older adults’ needs has become an increasingly useful method to improve health behaviors such as MA<sup>[33]</sup>. Technology-enabled diabetes self-management extends to mobile health modalities including apps. Older adult and HCP, community stakeholders identified the following areas of concern regarding smartphone availability and use: that they had limited

or no current app usage, inconsistent Internet access or storage data for smartphone and/or computer use, and preference for an app that has larger font, and distinct colors.

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## Conflict of interest statement

The authors declare that they have no financial conflict of interest with regard to the content of this report.

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