BMC Geriatrics

RESEARCH

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Development of content for a mobile application aimed to increase medication adherence among older adults

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Abstract

Background An increase in the use of health-related mobile applications is expected in the future. It is believed that mobile applications are valuable tools for patients, caregivers, and healthcare professionals. The use of mobile applications to improve medication adherence in older adults is effective, but it must be developed based on the special needs of older adults for high quality and long-term use. The aim of this Delphi survey study is to develop the content of a mobile application aimed to improve medication adherence among older adults by obtaining views from a panel including healthcare professionals, patients and patient care givers.

Methods An online Delphi method was implemented by using a questionnaire platform to obtain consensus on key content for a mobile application. Pharmacists, physicians, nurses, patients and patient caregivers were invited to participate in the consensus.

Results A total of 107 health care professionals, patients and care givers were invited to the study to develop consensus for the content of the mobile application. The response rates to three surveys were 56%, 90%, and 96%, respectively. Content including reminders for the patient on when to take the medicine, instructions for medications such as taking medication on an empty or full stomach or every morning or evening, feedback for getting new prescriptions when the medications are about to run out, information on what to do if the patient forgets to take the medication, and confirmation after the patient takes the medication, visual and written instructions for specific medications, information about medication doses specific to the patient's prescription, reminders to take medication one hour before or after based on the requirement of empty or full stomach administration and reminder when is the appropriate time for physician appointment were selected as critical.

Conclusions The content was created for the potential development of a mobile application to improve medication adherence. These findings could serve as a foundation for designing a mobile application tailored specifically for older adults in the future.

Clinical trial number Not applicable.

Keywords Medication adherence, Older adults, Mobile application, Digital health

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Introduction

Medication adherence in older adults is an important problem and a very complex situation due to the increasing number of chronic diseases, the large number of medications prescribed, and the complexity of the medication regimens [1–4]. Complex medication regimens are particularly difficult to manage for such populations, as they may involve various formulations, multiple daily doses, and, in some cases, special instructions for administration [1–4]. Cognitive and physiological changes that occur with advancing age may also lower the medication adherence [1]. When older adults do not take their medications as prescribed, negative clinical and financial effects can occur [5–7]. As a result, the therapeutic benefits of medications decrease; patients make more frequent hospital visits as their medical conditions worsen and they spend more money on healthcare [5, 8].

Information and communication technologies have emerged as a potential solution to help patients manage complex medication regimens and access necessary medication information [9, 10]. Mobile applications, in particular, support patients' health through individualisation, compatibility with body-worn sensors, and real-time information exchange, especially in the context of chronic diseases [9, 11]. A study regarding the usability of medication self-management mobile applications found that more than 14,000 applications could be downloaded, and it was revealed that the highest-rated applications lack basic functions such as helping older adults to organise their medication regimens and checking their medications [12]. In a systematic literature review aimed to evaluate the quality, features, privacy, and security measures of mobile applications for older adults in commercial application stores in Europe, 83 out of 1217 mobile applications were included. Mobile applications for older adults were found to be of medium quality [13]. The assessment of mobile applications was based on Mobile App Rating Scale which includes the five following criteria: engagement, functionality, aesthetics, and information quality which includes 23 items in total [14].

The number of mobile applications designed specifically for older adults is experiencing significant growth, driven by the increasing global aging population and the rising adoption of technology in older adults [15]. However, aging causes declines in vision, hearing, hand-motor skills, and information processing abilities which affects their use of mobile applications [16]. Thus, mobile applications must be accessible and user friendly for older adults to empower, engage and improve health outcomes [17]. Many mobile applications are not user-friendly for older adults due to small font size, complex navigation low contrast and complex layouts [17].

While some studies argue that the older adults may encounter several difficulties, such as anxiety and fear, lack of cognitive skills, health problems, lack of instructions, and cost when using mobile applications [18], other studies argue that although the older adults have historically been delayed in the adoption of new technologies, interest in the potential of digital technologies, especially mobile apps, to support healthy aging has been increasing [19, 20]. Additionally, for mobile applications to be effective, accurate and reliable information must be created with support from healthcare professionals [21]. Evidence-based strategies are promising for behaviour change during the development of mobile applications [22]. There is a need to develop a mobile application that is supported by evidence from a consensus between healthcare professionals and patients with consideration of the geriatric population's specific conditions. Only in this way can a quality, reliable, user-friendly and long-term usable mobile application be developed.

The aim of this study is to develop the content of a mobile application aimed to improve medication adherence among older adults by obtaining views from a panel including healthcare professionals, patients and patient care givers.

Methods

An online Delphi method was implemented by using a Google survey questionnaire platform [23]. Investigators, who were pharmacists, a pharmacy student and physicians specialised in geriatrics, developed the phase 1 survey questions based on the literature review such as systematic reviews and meta-analyses, randomised controlled trials and observational studies. In the first survey, 25 questions and a free text question in which participants could suggest additional items were included. Free texts were also present for each question for participants to share their additional remarks about the questions. The questions included the suggested content for a mobile application that aims to improve medication adherence in older adults. The demographics of the participants were collected once in the first survey.

The Delphi method uses a group of participants specially selected for their particular expertise therefore, physicians, pharmacists and nurses who have spent at least 1 year in their occupancy, preferably experience with geriatric care, were included in the list to invite for the study. Similarly, older adults who use at least one medication at least on year and care givers who took care at least one year for older adult were invited. Network sampling method was applied. Therefore, participants, including physicians, pharmacists, nurses, patients and patient caregivers, were invited via invitation emails including the survey links. Those who participated in the previous survey received the invitation for the next survey. The response rates were calculated.

The survey was designed to assign a score from 1 to 9 according to participants' judgement about the importance of the content that must be available in the mobile application [24]. The scores 1–3, 4–6, and 7–9 are described as unimportant, important and critical content in this study [24].

The online Delphi method included three phases. In the first survey, questions developed by the investigators were asked to be scored by the participants. Among the critical content, the agreement rate for items to be selected for the next survey was 85%. All participants were asked to rate the questions. When the question received scores 7–9 from 85% of the participants, the question were selected for the next phase. Those questions selected by the participants with 85% agreement and suggested newly were included in the phase 2 of the Delphi method. Then those questions selected by the participants with 85% agreement were included in phase 3 to have consensus on the content of the mobile application. The investigators' review reached a final consensus on the mobile application's content after participants' completion of the survey. Participants were given two weeks for completion of each survey. Those who still had not completed their surveys at the end of these two weeks were given an extra one week to complete their surveys.

The informed consents were obtained from the participants. This study was approved by the Ethics Committee for Human Research of Ankara University Faculty of Medicine (Date: 22.02.2023, Decision No: I02-82-23).

Table 1 Characteristics of the participants in the Delphi survey

Healthcare professionals, n=49	**Values**
Age, years [median (interquartile range)]	34 (30–39)
Gender, female	39 (80%)
Occupation, n (%)	
Pharmacist	32 (65%)
Physician	17 (35%)
Common specialty, n (%)	
Pharmaceutical science & pharmacy	21 (43%)
Geriatrics	11 (23%)
Clinical pharmacy	7 (14%)
Years in the occupation [median (interquartile range)]	10 (3–13)
Years in the care of older adults [median (interquartile range)]	1 (0–5)
Patients and care providers, n = 11	**Values**
Patients, n (%)	7 (64%)
Age, years [median (interquartile range)]	66 (62–72)
Gender, female, n (%)	6 (55%)
Education level, university degree, n (%)	10 (91%)
Income level, upper middle, n (%)	8 (73%)
Years for taking/administering medications [median (interquartile range)]	15 (10–28)
Living with family, n (%)	11 (100%)

Results

A total of 107 healthcare professionals, patients and patient caregivers were invited for the study. Among these, 56% of them participated in the first round of the survey. The majority of the healthcare professionals were pharmacists (65%) and the most common speciality was pharmaceutical sciences and pharmacy (43%). The mean ± SD years spent in the occupation and care for older adults were 9.78 ± 7.18 and 4.16 ± 6.58, respectively. The characteristics of the participants are demonstrated in Table 1.

The second survey was distributed to 60 participants. Among these, 90% of them responded to the second survey. The final survey was distributed to 54 participants. 96% of them completed the final survey ($n = 52$). The response rates of the participants are demonstrated in the Fig. 1.

The first, second and third phases of the surveys included 26 (1 open ended question), 22, and 12 questions, respectively. Based on the first survey, patients and/or caregivers scored more items (15 items) for the content as critical or important (4–9 scores) compared to the healthcare professionals (4 items). It seems that healthcare professionals were more cautious to share medication-related information in the mobile application. The agreements are compared in Table 2.

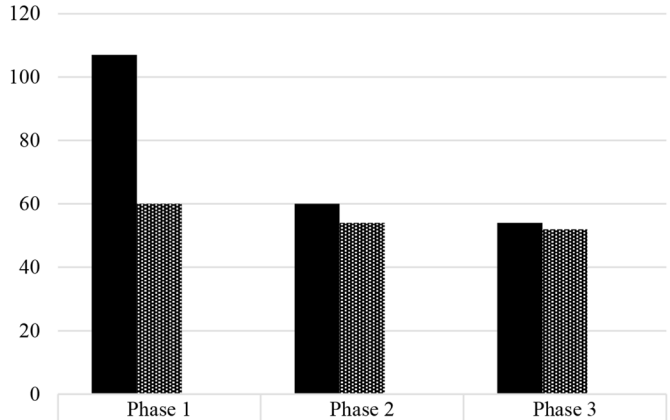
After the third survey, a total of 9 items were selected based on the consensus among the participants and the investigators' final review of the selected items. Figure 2 demonstrates the final items selected as essential content for the mobile application aimed at improving medication adherence in older adults.

Discussion

The use of digital technologies in health has become a frequently researched topic in recent years. According to WHO, digital health should be an integral part of health priorities and benefit people in an ethical, safe, secure, equitable and sustainable way [25]. The development of digital technologies should be carried out with the principles of transparency, accessibility, scalability, reproducibility, interoperability, privacy, security and confidentiality [25].

However, digital technologies are mostly developed by non-healthcare professionals, which makes them less usable or recommended. Therefore, this study was conducted to obtain consensus among healthcare professionals, patients and patient care givers for potential mobile application aims to improve medication adherence in older adults. A total of nine critical content of mobile applications has been identified.

Our study results showed that healthcare professionals were cautious to share more information about the medications with patients in the mobile application. For



	Phase 1	Phase 2	Phase 3
Number of participants received the invitation	107	60	54
Number of participants responded to the survey	60	54	52
Response rate	56%	90%	96%

Fig. 1 Response rates of the surveys

example, questions about medication information and instructions, 2 out of 8 questions were selected by the healthcare professionals while 6 out of 8 questions were selected by patients/care givers as critical and important content. Healthcare professionals believed that the extensive information provided by the mobile application might be misleading for older adults due to their limited health literacy. Additionally, if the application's information is not promptly synchronized with the existing electronic medical records or updates in medication therapy, it could lead to patient confusion and conflict patient-healthcare professional relationship.

None of the communication and support features were selected by the healthcare professional. They believed that such features which allows communication might be misused or increase the workload. Reliance on mobile app communication might prevent patients from seeking emergency care when needed.

The questions about laboratory results also not selected by the healthcare professionals. Although patients/care givers selected them as important content, they believed that patients are not able to evaluate them unless they were healthcare professional. Healthcare professionals tend to choose questions which can change medication take behaviour to improve adherence such as reminder of medication take and confirmation that patient took the medication.

To the best of our knowledge, this was the first study that obtained opinions from healthcare professionals and patients/care givers to develop a mobile application. Their willingness to participate in the study was important. As the points of contact for patients with medication-related issues, healthcare professionals play an essential role in advising patients about the use of mobile technologies and to evaluating the quality and reliability of such technologies. As the potential users of the mobile application, the participation of the patients and patient care givers was crucial to ensure the technology being developed meets their needs.

An increase in the use of health-related mobile applications is expected in the future. It is believed that mobile applications are valuable tools for patients, patient care givers, and healthcare professionals [26]. Studies have proven that health-related mobile applications can be effective, especially in the self-management of chronic diseases [21]. These applications help users save time and money by reducing the number of meetings between healthcare professionals and patients. Moreover, healthcare professionals can constantly check information about the patient's condition using user-entered data, making it easier for them to make decisions [21, 27, 28]. Compared to traditional care, mobile applications are effective interventions that help improve medication adherence in adults with chronic diseases [29]. In terms of medication adherence, it has been found that mobile applications that provide weekly motivational messages and remind medication timings reduce the number of days forgotten to take medication and increase medication adherence [30]. This is in line with our study where reminders and what to do if patient forgets to take the medication are critical component for a mobile application.

Mobile applications can be innovative solutions to help older adults maintain independence and improve their health and function [13]. They also have the potential to simplify social and medical care, which can contribute to the promotion of socialisation and support living at home in the longer term [13]. However, these positive

Table 2 Agreement on the content of mobile application as critical or important (4–9 scores) in the first Delphi survey

Potential content for mobile application	Critical for healthcare professionals	Critical for patients and care givers
Medication Reminders & Adherence		
1. Remind when to take the medicine	X	
2. Confirmation after patient takes the medication	X	
3. Positive feedback after the patient takes the medication		
4. Reminder to take medication one hour before or after based on the requirement of empty or full stomach administration		
5. Feedback for getting new prescriptions when the medications are about to run out		X
6. Reminder when is the appropriate time for physician appointment		X
7. Information about the patient's medication adherence to share with doctor/pharmacist at regular intervals		
8. Warning message to the patient's relatives or the relevant doctor/pharmacist if the patient's medication adherence is low		
Medication Information & Instructions		
9. Side effects of the medications the patient uses		
10. Instructions for medications such as taking medication in empty/full stomach or every morning/evening	X	X
11. Visual and written instructions for specific medications such as insulin and inhalers		X
12. Information on what to do if patient forgets to take the medication	X	X
13. Information about medication doses specific to patient's prescription		X
14. Drug or food interactions between the medications used by the patient		X
15. Warnings, messages or suggestions about lifestyle changes		
16. Information about the diseases		X
Health Monitoring & Medical Data		
17. Information about blood pressure, pulse, etc.		X
18. Laboratory results		X
Communication & Support Features		
19. Function that enables to communicate with the doctor		X
20. Function that enables to communicate with the pharmacist		X
21. Information about medication use behaviour not only with the patient but also with the patient's relatives		X
Visual Aids, Documentation and Technology Integration		
22. Images of the medications		
23. Images of the boxes of medications		
24. Special section that allows taking notes of important information about medications		X
25. Function that is compatible with wearable devices		X

results of mobile applications were obtained with short-term applied studies and low evidence [29]. For this reason, the same effect may not be expected from every mobile application in every period of use. Therefore, they must be carefully developed based on the specific conditions of the targeted group who are intended to use the mobile applications.

Although older adults are not capable of interacting with advanced technology, but they seem inclined to use such tools to manage their health [31]. There is evidence that mobile applications play a critical role in promoting medication adherence among older adults and our findings will help to improve the quality and usability of the potential mobile applications by providing a consensus of healthcare professionals and patients/care givers about the content.

The findings of this study can guide developers in considering the needs and values of healthcare professionals, patients, and patient care givers when designing mobile applications aimed at improving medication adherence in older adults. Since healthcare professionals recommend these applications and patients/ care givers use them, both groups must reach a consensus on the app's features to ensure sustainable usage. Since not all mobile applications include all these components, the nine components identified in this study should be incorporated into all mobile applications, as they represent essential features agreed upon through consensus.

There were several limitations of the study. The Delphi survey was dominated by the healthcare professionals, as the number of healthcare professionals was higher than the number of patients and care givers. This resulted from network sampling, where healthcare professionals engaged more with their colleagues than their patients to avoid influencing patient participation. An agreement rate of 85% reduced this risk because patients must have

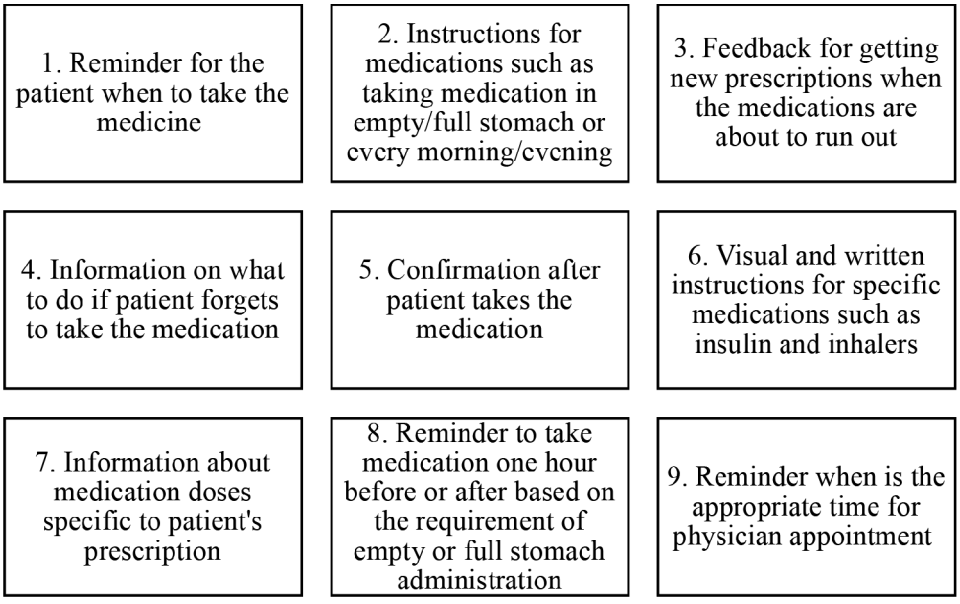


Fig. 2 Items selected as essential content for the mobile application

agreed to the item to achieve higher percentages in the scores. None of the nurses invited at the beginning of the study participated despite the reminders. Other factors, such as cultural, societal and ethnic differences, may affect medication use and adherence in older adults; therefore, more studies on the content development of mobile applications for medication adherence are necessary.

Conclusion

Not all mobile applications include the critical components necessary for supporting medication adherence in older adults. The nine components identified in this study should be integrated into all such applications, as they have been established through consensus as essential for adherence.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12877-025-05994-7.

Supplementary Material 1

Acknowledgements
Authors are grateful to all survey participants including pharmacists, physicians, patients and patient care givers.

Author contributions
AS, VA, and AY conducted developmental work to conceptualise the research idea. All authors actively contributed to the research design. AS, VA, and SS collected, analysed and interpreted the data from the surveys. AB and MV provided academic mentorship. All authors read and approved the final manuscript.

Funding
Not applicable.

Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the Ethics Committee for Human Research of Ankara University Faculty of Medicine (Date: 22.02.2023, Decision No: I02-82-23) and adhered to the principles of the Helsinki Declaration. An informed consent form was obtained from the students at the beginning of the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 18 November 2024 / Accepted: 28 April 2025
Published online: 13 May 2025

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