



Mobile Application for Digital Health Coaching in the Self-Management of Older Adults with Multiple Chronic Conditions: A Development and Usability Study

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Objectives: This study was conducted to develop a mobile application for digital health coaching to support self-management in older adults with multiple chronic conditions. Additionally, the usability of this application was evaluated. **Methods:** The HAHA2022 mobile application was developed through a multidisciplinary team approach, incorporating digital health coaching strategies targeting community-dwelling older adults with multiple chronic conditions. Usability was assessed with the Korean version of the Mobile Application Rating Scale. The usability tests involved eight expert panel members and 10 older adults (mean age, 74 ± 3 years; 90% women) from one senior welfare center. **Results:** HAHA2022 is an Android-based mobile application that is also integrated into wearable devices to track physical activity. It features an age-friendly design and includes five main menus: Home, Action Plan, Education, Health Log, and Community. The average overall usability test scores—covering engagement, functionality, aesthetics, and information—were 4.27 of 5 for the expert panel and 4.53 of 5 for the older adults. **Conclusions:** The HAHA2022 application was developed to improve self-management among community-dwelling older adults with multiple chronic conditions. Usability tests indicate that the application is highly acceptable and feasible for use by this population. Consequently, HAHA2022 is anticipated to be widely implemented. Nonetheless, further research is required to confirm its effectiveness through digital health intervention.

Keywords: Mobile Applications, Aged, Self-Management, Digital Health, User-Centered Design

Submitted: July 20, 2024

Revised: 1st, October 16, 2024; 2nd, October 21, 2024

Accepted: October 22, 2024

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I. Introduction

The proportion of older adults (those aged 65 years and older) is rapidly increasing worldwide, especially in South Korea, where it is expected to exceed 40% by 2050 [1]. Alongside this demographic shift, the prevalence of chronic diseases has risen as well; in 2020, 84.0% of older adults in South Korea were reported to have at least one chronic disease, and 54.9% were dealing with two or more chronic diseases, a situation referred to as multiple chronic conditions [1]. The increase in the number of older adults living with multiple

chronic conditions highlights the importance of self-management. While research has extensively documented the prevalence, mortality rates, and financial burdens of these diseases, the literature includes a relative lack of emphasis on providing effective support for affected individuals and populations [2].

Aging societies, the coronavirus disease 2019 pandemic, and digital transformation have rapidly revolutionized the global healthcare system. Digital health technologies, including mobile health, telehealth, and wearable devices, are promising tools for promoting health and managing chronic diseases among older adults [3]. Digital health technology offers a cost-effective solution that overcomes traditional barriers such as distance and time, facilitates access to healthcare, and supports self-management through behavioral changes [4].

Despite the benefits of digital health technologies, previous studies have shown that about half of older adults discontinue using mobile health applications (apps) within 2 weeks, underscoring their limited acceptance in this demographic [5]. Therefore, when developing apps for older adults, it is essential to prioritize usability by considering the natural changes of aging, including declines in vision, hearing, motor skills, and cognition [6,7]. Additionally, for effective digital health interventions, it is necessary to utilize digital health coaching strategies that comprise digital engagement, communication with healthcare providers, and human contact [8]. Digital health coaching, which combines digital technologies with health coaching, provides personalized healthcare feedback and motivation, effectively promoting health behavior changes and improving self-management for older adults with chronic diseases [9].

Usability is a key factor in the adoption of digital health technologies. Usability testing represents a crucial step in app development; however, it is often overlooked even in the context of the enormous recent increase in mobile health apps [5]. Furthermore, previous research indicates a lack of comprehensive description of the development process for mobile health apps targeting older adults, indicating a need for studies to improve productivity and reduce the waste of resources and time [10].

Accordingly, our objective was to develop an age-friendly self-management mobile application that incorporates digital health coaching strategies for older adults with multiple chronic conditions. Additionally, we evaluated the app's usability.

II. Methods

This developmental study aimed to develop and assess the usability of a mobile application, HAHA2022, an acronym for “Happy Aging, Healthy Aging 2022.”

1. Development

The contents of the HAHA2022 app were designed based on the researcher's previous studies [11,12], a needs assessment comprising a preliminary survey and focus group interviews with older adults [13,14], Living a Healthy Life with Chronic Conditions by Lorig [15], and verified information from the Korea Disease Control and Prevention Agency's National Health Information Portal and the Korea Health Promotion Institute.

The survey and interviews identified key needs for the self-management of older adults, including “communication with healthcare providers” and “information on disease management” [13,14]. Notable factors facilitating the adoption of digital technology included “age-friendly design,” “cost of digital devices and services,” “personal reminders,” and “shared goal-setting,” while “lack of human contact” was identified as a barrier [13,14].

Based on the literature review, most studies focused on disease-specific interventions, with limited emphasis on multiple chronic conditions. Mobile phones emerged as the most frequently utilized digital devices, and the predominant approach to interventions was non-contact, with hybrid delivery models rarely used. These findings highlight the need to develop and evaluate mobile-based self-management programs for older adults with multiple chronic conditions.

The HAHA2022 app was created by a multidisciplinary team that included experts in gerontological nursing and medical engineering, software developers, user interface/user experience (UI/UX) designers, and professional app programmers. Since over 90% of South Korean older adults with smartphones use the Android platform [16], the mobile app production environment was developed for the Android operating system. The development of the HAHA2022 app utilized rapid prototyping, an iterative design approach that enables quick refinement of functionality through frequent updates and multiple short cycles [17]. When interacting with technology, older adults often face physical challenges, such as visual, auditory, and motor coordination difficulties, as well as cognitive challenges like memory and attention decline [18]. Consequently, mobile app development must incorporate a user-centered design. The HAHA2022 app prioritized age-friendly features to improve usability [5]. Ad-

ditionally, we created a web-based administration portal to allow the research team and app developers to monitor logs and address technological issues.

2. Evaluation (Usability Testing)

HAHA2022 was evaluated by two groups: an expert panel and a sample of older adults, who represent the application's intended user base. In alignment with Nielsen's findings [19], the usability test included eight expert panel members and 10 older adults. All measurements used received approval from the original authors and the Korean translators.

1) Expert panel

The expert panel comprised eight professionals: two professors of gerontological nursing, a professor of nursing informatics, a professor of medical engineering, a nursing researcher who had developed a mobile healthcare app, a community healthcare specialist, and two nurses at a senior welfare center. The evaluation of HAHA2022 utilized the Korean version of the Mobile Application Rating Scale (MARS) [20]. The MARS is a widely recognized tool for assessing the quality of mobile health applications, demonstrating reliability and high internal consistency (Cronbach's $\alpha = 0.90$) [21]. It comprises 23 items across five quality subscales: engagement, functionality, aesthetics, information, and subjective quality. Each item is rated using a 5-point Likert scale (1, inadequate; 2, poor; 3, acceptable; 4, good; 5, excellent), with scores above 3 indicating high quality.

2) User participants

To evaluate the usability of the mobile app, convenience sampling was employed to recruit older adults from a single representative senior welfare center in Seoul, South Korea. The inclusion criteria were as follows: (1) being 65 years of age or older; (2) having no cognitive impairments that could interfere with study participation, as indicated by the Korean version of Mini-Mental State Examination score above 24; (3) having a diagnosis of two or more chronic diseases and being on at least one medication; and (4) having experience with two-way communication via smartphone-based social network services.

HAHA2022 was also assessed using a Korean translation of the user version of the MARS (uMARS) [22]. This scale consists of 26 items across six quality subscales: engagement, functionality, aesthetics, information quality, subjective quality, and perceived impact. It has demonstrated high internal consistency, with a Cronbach's α of 0.90 [23]. Each item is rated on a 5-point Likert scale, where 1 indicates "inad-

equate" and 5 signifies "excellent."

Data collection for the usability evaluation of the HAHA2022 app, designed for older adults with multiple chronic conditions, occurred in July 2022. Ten older adults, ranging in age from 65 to 79 years (90% of whom were female), used the app for 2 weeks and participated in the usability test. Participant characteristics are detailed in Table 1. Research assistants, who were not affiliated with the study, were recruited and received training on the study's procedures and measurements prior to data collection. Following training, they conducted in-person, one-on-one usability evaluations with the participants.

3. Ethical Consideration

This study received approval from the Institutional Review Board of Seoul National University (IRB No. 2207/003-005) and was conducted in accordance with the Declaration of Helsinki. After explaining the purpose and process of the study, we obtained written informed consent from all participants.

III. Results

1. Development

The HAHA2022 app was developed to support older adults

Table 1. Demographic characteristics of older adults (n = 10)

Characteristic	Value
Sex	
Female	9 (90.0)
Male	1 (10.0)
Age (yr)	74 $\pm$ 4
65–74	6 (60.0)
≥ 75	4 (40.0)
Education level	
Elementary school	3 (30.0)
Middle school	5 (50.0)
College	2 (20.0)
Number of chronic diseases	3.2 $\pm$ 1.1
Hypertension & hyperlipidemia	3
Hypertension & diabetes mellitus	3
Hyperlipidemia & diabetes mellitus	4
Arthritis & others	4

Values are presented as number (%) or mean $\pm$ standard deviation.

with multiple chronic conditions via a health coaching strategy. It features five main menus: Home, Action Plan, Education, Health Log, and Community, detailed in Figure 1 and Table 2.

The Home menu presents a weekly action plan and displays graphs indicating the status of achievements. It also features icons that link to the Health Log submenus, which display daily recorded data. As reported by Lorig et al. [24], an action plan is an effective tool for improving health behavior and self-efficacy. In the present study, participants could set personalized goals in one-on-one sessions with nurse health coaches over the phone. Their progress was then monitored through graphs in the Action Plan. The Health Log menu includes sections for Physical Activity, Medication, Nutrition, and Sleep. Participants can log their daily steps, medication intake, meals, and both the duration and quality of sleep. Daily steps are automatically recorded by a wearable device (smart band).

The daily logs provided in the app are evaluated through a progress display and can be monitored on an administration website by the research team. The Education menu includes videos that correspond to the weekly action plan. For each

topic, participants can watch a 20-minute main video and four shorter additional videos, each approximately 5 minutes long, which reinforce the key messages of the main video. Table 3 presents a detailed list of the video contents. The videos were produced by the research team using PowerPoint presentations with voice-over narration. Participants could also replay past videos as needed. Upon completing a quiz or photo-upload mission after watching the videos, participants receive positive feedback. Additional resources, such as articles and authorized video links on chronic disease self-management, are also provided. The Community menu includes a bulletin board where all participants can post, upload photos, comment, and “like” posts, fostering interaction with other participants and the research team. These interactive features are designed to keep users engaged and connected, enhancing their experience with the app.

Based on a literature review of UI and UX design for mobile apps targeting older adults [5-8], the HAHA2022 app was planned with the physical and cognitive challenges of this demographic in mind. The review informed the initial design, enabling us to incorporate features promoting user-centered design for an older adults. Specifically, the app



Figure 1. Screenshots of the HAHA2022 application.

Table 2. Overview of the HAHA2022 application

Menu	Health coaching strategy	Description
Home	• Motivation • Self-monitoring • Communication	• Daily achievement status graph based on the weekly action plan topics and prompts. • Current daily health records shown in gauge format, with icons linking to individual health record entry screens. • In-app chat button for communication with the health coach available on every screen.
Action plan	• Collaborative and individualized goal-setting • Active engagement • Health coaching • Self-efficacy	• Set individualized weekly action plans after telephone calls with health coach (nurse). • Goals include symptom management, medication adherence, physical activity, nutrition intake, sleep hygiene, tooth brushing, and stress management. • Assess confidence in completing an action plan. • Provide positive feedback to encourage active engagement.
Education	• Health and lifestyle education related to self-management	• Weekly educational videos created by the research team aligned with the action plan. • Each topic consists of one main video (20 minutes) and four short videos (each approximately 5 minutes). • After viewing, users complete an OX quiz or submit a photo mission related to the topic. • Access resources include articles and video links on chronic disease self-management.
Health log	• Self-monitoring • Self-management • Health behavior change • Reminder • Feedback	• Record health log (physical activity, taking medication, food diary, and sleep patterns and quality). • Physical activity data is tracked automatically via smart band. • Personalized reminders are generated based on the user's input. • Provide automated feedback messages about the user's health log with a text-to-speech function.
Community	• Social support with peer groups	• Participants can share ideas through a community bulletin board. • Users can upload posts or photos, comment, and like posts. • Set up user profile and view application information.

featured large fonts, minimal text, a limited color palette for visual clarity, and audio alternatives such as text-to-speech functionality. Additionally, to address motor coordination issues, it employed simple touchscreen gestures, such as swiping and tapping, and avoided complex gestures like pinch-to-zoom. To accommodate declines in memory and attention, we shortened the length of videos, provided a large and straightforward layout, placed main menus on the home screen, and used clear buttons with an intuitive structure. Complex jargon and English words were substituted with simpler Korean terms to facilitate ease of understanding. Throughout the development process, regular consultations were held with system developers, UI/UX designers, and gerontological nursing experts. These panels provided ongoing feedback that led to continuous refinements, ensuring the app remained user-friendly and appropriate for older adults. Revisions were made iteratively based on this expert feedback, with an emphasis on maintaining an age-friendly and user-centered design.

2. Evaluation (Usability Testing)

1) Expert panel

Eight expert panel members evaluated the HAHA2022 app, providing feedback on its content and offering advice. The mean scores for engagement, functionality, aesthetics, information, and subjective quality were 3.98, 4.41, 4.46, 4.24, and 3.91, respectively (Table 4). Regarding the items within the subscales, the highest average score pertained to ease of use and graphics, while the lowest was for willingness to pay. There was also feedback that peer group support through community features could increase motivation for self-management. Furthermore, since the wearable device is currently limited to tracking physical activities, it was suggested that adding more sensors and features to monitor sleep and diet would be beneficial.

2) User participants

The HAHA2022 app was distributed to participants and installed on their smartphones as an APK file. After receiving detailed instructions on how to use the app, participants were provided an A4-sized handbook that provided a step-

Table 3. Contents of the mobile application

Category	Mobile application contents
Symptoms management	• Understanding and managing common symptoms (fatigue, pain, and shortness of breath) • The vicious cycle of symptoms • How to write a symptom diary
Medication adherence	• Importance of taking medication • Finding and learning about adverse reactions • How to deal with side effects of medicine • Medication reminder
Physical activity	• Importance of physical activity • Physical activity guidelines • Precautions for physical activity • Videos about walking, strength, and balance exercises
Healthy diet	• Importance of a healthy diet • Dietary guidelines for Korean older adults • Choosing healthy and balanced meals • Drinking sufficient water • Avoid the harmful use of alcohol
Sleep and stress	• Importance of good sleep • Changes in sleep patterns with aging • Sleep hygiene and habits • Skills to deal with sleep problems and negative emotions • Relaxation techniques
Oral health	• Importance of oral health • Changes in oral condition with aging • How to properly clean and maintain dentures • The proper brushing technique • Quitting smoking
Coping strategies	• How to find resources and get help • Problem-solving skills. • Communication with family, friends, and healthcare providers

by-step tutorial for each feature. This included guidance on connecting the smart band, entering health records, and contacting the research team for technical support, illustrated with screenshots. The handbook was designed with larger fonts, simplified language, and clear visual aids to accommodate the needs of older users. A designer with a fine arts background created the illustrations, while a geriatric nursing professor reviewed the content to ensure its relevance and clarity. Participants were also given a wearable device (smart band) to monitor their physical activity, which was linked to the app. They set weekly goals and established action plans for medication adherence and maintaining a healthy diet. Additionally, they watched daily educational videos; maintained health logs on physical activity, medication intake, nutrition, and sleep; and executed their weekly

action plans.

The users also interacted with other participants or research team members by utilizing the community feature, where they could upload posts or photos and leave comments or likes. The research team, consisting of nurses, offered motivation and personalized health coaching feedback through weekly telephone calls lasting about 15 minutes. The team also guided participants on obtaining technical assistance when necessary. All participants accessed the app daily and logged their health data for 2 weeks.

The mean quality scores for the app in engagement, functionality, aesthetics, information, and subjective quality were 4.32, 4.55, 4.57, 4.70, and 3.73, respectively (Table 5). Regarding items within these subscales, each information item achieved a mean of 4.7 points, while gestural design received

Table 4. Usability evaluation of HAHA2022 by an expert panel

Variable	Score
Engagement	3.98 ± 0.64
1. Entertainment	4.00 ± 0.00
2. Interest	4.13 ± 0.64
3. Customization	3.88 ± 1.13
4. Interactivity	3.75 ± 1.28
5. Target group	4.13 ± 0.64
Functionality	4.41 ± 0.52
1. Performance	4.25 ± 0.71
2. Ease of use	4.63 ± 0.52
3. Navigation	4.38 ± 0.52
4. Gestural design	4.38 ± 0.74
Aesthetics	4.46 ± 0.40
1. Layout	4.50 ± 0.53
2. Graphics	4.63 ± 0.52
3. Visual appeal	4.25 ± 0.46
Information	4.24 ± 0.45
1. Accuracy of application description	4.25 ± 0.71
2. Goals	4.38 ± 0.52
3. Quality of information	4.43 ± 0.53
4. Quantity of information	4.29 ± 0.95
5. Visual information	4.38 ± 0.52
6. Credibility	4.13 ± 0.35
7. Evidence base	3.50 ± 0.58
Application subjective quality	3.91 ± 0.30
1. Would you recommend this app to people who might benefit from it?	4.13 ± 0.64
2. How many times would you use this app in the next 12 months if it were relevant to you?	4.38 ± 0.52
3. Would you pay for this app?	3.13 ± 0.99
4. What is your overall star rating of the app?	4.00 ± 0.53

Values are presented as mean ± standard deviation.

the highest score at 5.0. The item with the lowest score was willingness to pay, at 2.30 ± 1.25 . The perceived impact of the app on chronic disease self-management was rated at 4.23 ± 0.53 .

IV. Discussion

This study reports the development and evaluation of a mobile application designed for digital health coaching on self-management in older adults with multiple chronic conditions. The application, HAHA2022, received high usability ratings from both an expert panel and a group of older adults, suggesting that it is a well-designed and user-friendly

app for older adults.

Previous research evaluating lifestyle management apps using the Korean MARS reported an average score of 3.4 [25]. In comparison, HAHA2022 received higher average scores, at 4.20 from the expert panel and 4.37 from users. Experts and users provided similar overall scores, with users assigning slightly higher ratings. The expert panel gave the highest scores for “aesthetics,” while users rated “information” highest.

Previous research [26] indicates that experts focus on aesthetic factors such as layout, colors, graphic design, and visual appeal when evaluating apps. This suggests that HAHA2022 was perceived as orderly, well-designed, and professional.

Table 5. Usability evaluation of HAHA2022 by older adults

Variable	Score
Engagement	4.32 ± 0.63
1. Entertainment	4.60 ± 0.52
2. Interest	4.50 ± 0.71
3. Customization	4.20 ± 1.03
4. Interactivity	3.50 ± 1.51
5. Target group	4.80 ± 0.42
Functionality	4.55 ± 0.55
1. Performance	4.50 ± 0.71
2. Ease of use	4.30 ± 0.82
3. Navigation	4.40 ± 0.84
4. Gestural design	5.00 ± 0.00
Aesthetics	4.57 ± 0.50
1. Layout	4.60 ± 0.52
2. Graphics	4.60 ± 0.70
3. Visual appeal	4.50 ± 0.71
Information	4.70 ± 0.67
1. Quality of information	4.70 ± 0.48
2. Quantity of information	4.70 ± 0.67
3. Visual information	4.70 ± 0.48
4. Credibility of score	4.70 ± 0.67
Application subjective quality	3.73 ± 0.61
1. Would you recommend this app to people who might benefit from it?	3.70 ± 1.06
2. How many times do you think you would use this app in the next 12 months if it were relevant to you?	4.80 ± 0.42
3. Would you pay for this app?	2.30 ± 1.25
4. What is your overall star rating of the app?	4.10 ± 0.74
Chronic disease self-management	4.23 ± 0.53
1. Awareness	4.40 ± 0.82
2. Knowledge	4.40 ± 0.70
3. Attitudes	4.00 ± 1.05
4. Intention to change	4.60 ± 0.70
5. Help-seeking	3.50 ± 1.08
6. Behavior change	4.60 ± 0.70

Values are presented as mean ± standard deviation.

The fact that users assigned the highest score to “information” suggests that HAHA2022 contains credible content, which may be augmented by the digital health coaching delivered via telephone call by nurse members of the research team.

In addition to these assessments, we collected qualitative feedback through open-ended questions, which allowed participants to share their thoughts on the app’s usability. For instance, some users noted occasional errors in step tracking

synchronization. In response, we worked with the developers to update the system, improving the sync between the smart band and the app. Any data that were not properly collected were manually entered by the research team via the admin web page. Separately, in response to comments about video playback, we advised users of the option to enlarge the video for a more comfortable viewing experience by clicking the full-screen button. Many participants reported satisfaction with the app, describing it as user-friendly and helpful. Some

even indicated that they would recommend it to friends.

Among the sub-items of uMARS evaluated by users, “target group” and “willingness to use” received the highest scores. This outcome is promising, especially considering that previous research has shown a gradual decline in technology usage among older adults regarding digital health interventions [10]. Additionally, the expert panel awarded the highest score to “ease of use.” These findings suggest that the HAH2022 app is well-suited for older adults, featuring age-friendly design elements such as large fonts, simplified gestures, and intuitive layouts to mitigate physical and cognitive challenges. Such design ensures that the app effectively delivers content that is realistic and engaging, accommodating the diverse levels of technological proficiency found among older adults. The results also imply that the combination of digital health coaching with age-friendly features represented an effective strategy. Usability is a key factor in the adoption of healthcare mobile apps, and it is anticipated to improve self-management and well-being in the older adult population [5].

Despite the overall positive feedback, the low willingness-to-pay scores from experts and users indicate that the cost of digital devices and internet services represents a major barrier to technology adoption [27]. The technology must be user-friendly, functional, and affordable. Prior research underscores the importance of considering economic factors when designing healthcare technologies for older adults, as high costs can hinder their adoption of new technologies [28]. This also suggests the need for financing strategies; for instance, our research team provided data coupons to all participants to ensure stable internet access. Moreover, payment plans may be perceived as burdensome by older adults who do not see an immediate or clear need for these technologies [28]. Accordingly, an alternative approach could be to more effectively communicate the long-term financial benefits of healthcare technologies to older adults. This would improve their understanding of potential savings overall and encourage their investment in managing future healthcare expenses.

The app’s influence on chronic disease self-management was markedly positive, reflected by an average score of 4.23. It includes features such as health logging, educational content, reminders, and digital health coaching strategies—such as communication, human interaction, and personalization—all of which support effective self-management in older adults. Nevertheless, further research is needed to confirm the app’s long-term effectiveness in managing multiple chronic conditions in this population. Moreover, digital

health coaching is resource-intensive, posing challenges to scalability. This obstacle may be overcome by thoughtfully incorporating advanced technologies such as artificial intelligence.

This study has several limitations and carries implications for future research. First, the generalizability of the results is constrained due to the study being conducted at a single institution. Second, given the growing number of digital health technology studies focusing on older adults, we recommend involving this demographic in the design and development stages to promote a user-centered approach. Third, self-reported data could be better complemented by collecting additional person-generated health data, such as blood pressure and blood glucose levels, sleep cycles, and electrocardiogram readings, through various digital technologies.

The high usability score of HAH2022 indicates its potential to bridge the digital divide in self-management for older adults by utilizing digital health technologies. Its age-friendly features and digital health coaching capabilities could promote both the successful adoption and ongoing use of the mobile health app among this demographic, thus helping to prevent digital disparities and health inequities.

Conflict of Interest

Kwang Gi Kim is an editorial member of Healthcare Informatics Research; however, he did not involve in the peer reviewer selection, evaluation, and decision process of this article. Otherwise, no potential conflict of interest relevant to this article was reported.

Acknowledgments

The authors express their sincere appreciation to everyone who contributed directly or indirectly at every stage of this study.

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT) (Grant No. 2021R1A2C200622212).

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