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The psychometric assessment of the provider version of mHealth App Usability Questionnaire (MAUQ) in persian language

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Abstract

Introduction mHealth apps are widely utilized in healthcare. To guarantee their usefulness and usability, it is crucial to assess them using a reliable scale tailored specifically for mHealth apps and their users.

Objective The aim of this study is the psychometric assessment of the provider version of mHealth App Usability Questionnaire (MAUQ) in Persian language.

Method The Persian translations of standalone and interactive versions of the MAUQ for healthcare providers underwent validation. Face validity, content validity, and factor analysis were conducted to validate these two versions. Ten nurses evaluated face validity, while ten nursing and psychometric analysis experts assessed content validity. Factor analysis involved 98 nurses. The reliability of the questionnaires was measured using Cronbach's alpha.

Results The translated questionnaires were validated, confirming both face validity (impact score ≥ 2.40) and content validity (k*≥0.66). The Persian version of the MAUQ for standalone applications had 18 items across two dimensions: easy to use and usefulness (11 items) and user interface and satisfaction (7 items). The Persian version of the MAUQ for interactive applications had 21 items across three dimensions: easy to use (4 items), usefulness (5 items), and user interface and satisfaction (12 items). Both standalone and interactive versions demonstrated high internal consistency with a Cronbach's alpha of 0.96.

Conclusions The psychometric assessment of the provider version of MAUQ in Persian language has the reliability and validity required to assess mHealth applications usability.

Keywords MAUQ, Mobile apps, Telemedicine, Usability questionnaire, Psychometric assessment, Persian language

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Introduction

Mobile health applications (mHealth apps) can serve multiple purposes, including managing wellness, facilitating behavior change, collecting health data, managing diseases, enabling self-diagnosis and rehabilitation, and functioning as an electronic patient portal and medication reminder [1]. Various studies [2, 3] have shown that well-designed mHealth apps can empower patients, improve treatment adherence, and reduce healthcare costs. Mustafa et al. [4] believed that mHealth apps should be designed with good usability, be easy to use and error-free, and be able to effectively help people reach their goals. Nevertheless, certain studies [5, 6] have demonstrated that users may decrease their usage or altogether avoid an application due to poor design resulting from usability issues.

There are several methods for evaluating the usability of mHealth apps and identifying their issues, but usability questionnaires are the most commonly used due to their simplicity in implementation and data analysis [1]. On the other hand, there are various questionnaires available to evaluate usability od mHealth applications. The most popular and widely used questionnaires are the Post-Study System Usability Questionnaire (PSSUQ) and the System Usability Scale (SUS) [7]. Although these two questionnaires are used to measure some aspects of the usability of mobile health applications, they primarily focus on general usability metrics such as ease of use, learnability, efficiency, and satisfaction, which may not fully capture the complexities and unique factors of mHealth applications [8, 9]. For instance, mHealth apps often involve specific functionalities like real-time health data monitoring, integration with medical devices, and adherence to treatment plans, which require assessments beyond standard usability criteria [10]. Moreover, the context of use in mHealth, including users' health conditions, and regulatory compliance, necessitates evaluation frameworks that address safety, trustworthiness of health information, and user experience aspects beyond what PSSUQ and SUS typically measure [11, 12].

One of the mobile usability evaluation questionnaires that can provide appropriate information about the unique factors of mHealth apps is the mHealth App Usability Questionnaire (MAUQ) [1, 13]. The MAUQ is specifically designed to evaluate the usability of mobile-based health applications and is available in four versions to evaluate interactive or stand-alone mHealth apps among patients or healthcare providers [1]. Moreover, It includes sections to evaluate the app's functionality and performance, such as ease of navigation, clarity of information presentation, and responsiveness to user interactions. MAUQ also incorporates aspects specific to mHealth, such as the integration of health data and information, and the app's ability to support users in managing their health effectively [1, 8]. Another key component assesses user satisfaction and perceived usefulness, crucial for understanding the app's impact on user engagement and adherence to health goals. Additionally, MAUQ addresses contextual factors like the user's health condition and technological proficiency, ensuring that usability evaluations consider diverse user needs and scenarios [8].

To the best of our knowledge, the Persian version of MAUQ has not yet been translated and validated; however, other studies have translated and validated MAUQ into Chinese [14], Malay [4], and Spanish [15], and reported high reliability and validity similar to the original English version. Therefore, the aim of the present study is the psychometric assessment of the provider version of MAUQ in Persian language.

Methods

Study design

This was a cross-sectional and a psychometric study. In this study the standalone and interactive versions of MAUQ for healthcare provider were translated and validated in Persian. Before starting the study, the authors obtained permission from the main developers of the MAUQ (English version) through email. The data were collected from 98 nurses working in hospitals affiliated to Kerman University of Medical Sciences (KMUS), Kerman, Iran, since January to March 2023. These nurses were selected with simple random sampling method. Nurses were chosen as the target community due to their availability and frequent use of "Parastar pelas+"nursing applications, which made them well-suited for evaluating the usability of mHealth applications tailored to healthcare providers.

Inclusion and exclusion criteria

The inclusion criteria for participants were that they use smartphones and the exclusion criteria were unwillingness to participate in the study.

The used standalone and interactive applications

The participants used the "Parastar pelas+" as a standalone application, and "Asanism" as an interactive application. "Parastar pelas+" is an application designed to calculate drug dose estimates for optimal patient care by nurses. "Asanism" is an application that offers various nursing services for patient home care. Patients can choose the type of service they need (such as injections, replacement of urinary catheter and etc.), and a nurse will visit them at home to provide these services. In addition, the application provides tele-counseling services to patients.

MAUQ

MAUQ was developed by Zhou, et al. in 2019 for evaluating the usability of standalone and interactive mHealth apps [1]. The MAUQ has four versions. The patient version and the healthcare provider version each have two versions for standalone and interactive applications. The MAUQ for standalone applications (patient and provider versions) has 18 items in three sections including ease of use, interface and satisfaction, and usefulness. However, the MAUQ for interactive applications (patient and provider versions) has 21 items in three sections, including ease of use and satisfaction, system information arrangement, and usefulness. The questionnaires' items were designed based on the 7-point scale (1 (strongly disagree) to 7 (strongly agree)). The criterion and construct validity of MAUQ displayed that it correlates with the PSSUQ (r=0.8448) and the SUS (r=0.6425). The factor analysis also displayed acceptable validity. The reliability of the MAUQ was confirmed with Cronbach's alpha more than 0.80 [1].

Questionnaire translation and adaptation

The standalone and interactive versions of MAUQ for providers were translated from English to Persian using the Forward-Backward method [16]. At the first stage (forward translation), these two versions of MAUQ were translated by two independent translators who are proficient in both English and Persian languages. At the second stage (backward translation), after combining the initial translations into a single translation, these two versions of MAUQ were translated from Persian to English by two independent translators. Then, two translated versions (Persian and English) were reviewed by the research team and the discussion about them was performed in a meeting to achieve consensus.

Validity and reliability of persian version

The validation process of the standalone and interactive versions of MAUQ was done by calculating face validity, content validity index (CVI), and factor analysis. For the face validity, the online translated questionnaires were sent to ten individuals from purpose group (nurses) and asked them to answer the questions. All of the questionnaires' items were scaled in 5 levels (1 (not important at all) to 5 (highly important)). After completing all questionnaires, the impact score was calculated for each item using the following formula:

Impact score = Frequency (%)* Importance.

The impact scores > 1.5 were considered acceptable [17].

For the CVI calculation, the online translated questionnaires were sent to 10 experts in nursing and psychometric analysis and asked them to answer the questions. All of the questionnaires' items were scaled in 4 levels (1 (not related) to 4 (highly related)). After completing all questionnaires, the CVI was calculated for each item using the following formula:

$$\mathrm{CVI} = \frac{\text{number of raters giving a rating of 3 or 4}}{\text{total number of raters}}$$

After that the modified kappa statistic was calculated using CVI and the probability of chance agreement (Pc) using the following formula [18]:

$Pc = [(N!/A!)\,(N-A)!\,] * 0.5^{N}$.

$K^{*} = (CVI-Pc) / (1-Pc)$.

If the value of the modified kappa statistic for each item is greater than 0.74, it is considered excellent; between 0.60 and 0.74 is considered good; and less than 0.60 is considered fair, in which case the item should be omitted from the questionnaire [19, 20].

For the factor analysis, after completing questionnaire by 98 nurses working in hospitals affiliated to KMUS, the Kaiser-Meyer-Olkin (KMO) index and Bartlett's test of sphericity were used to evaluate sampling adequacy. If the value of KMO was >0.9 considered as excellent, 0.8 to 0.9 considered as high, 0.7 to 0.8 considered as good and 0.5 to 0.7 considered average. The Bartlett's test of sphericity was considered significant if the Pvalue was <0.05 [21]. Factor analysis of the questionnaires was then performed using Principal Components Analysis with Varimax Rotation. If the value of factor loading for each item was >0.5, the item was loaded in the relevant factor. When an item was loaded in more than one factor, the higher value was considered [22].

The reliability of the questionnaires was checked using Cronbach's alpha as the internal consistency index. Cronbach's alpha ≥ 0.70 was considered acceptable [23]. The methodology of the study was showed in Fig. 1.

Data analysis of participants demographic

In order to investigate the relationship between the demographic characteristics of the participants with the standalone and interaction version of the MAUQ questionnaire, t-test and ANOVA were used. Data were analyzed using Microsoft Excel version 2016 and SPSS version 22.

Ethical considerations

This study was registered with 401,000,906 code in Kerman University of Medical Sciences and was approved by ethical committee of this university. The Ethic approval code is IR.KMU.REC.1401.518.

Results

Table 1 shows the face and content validity of the Persian version of the MAUQ for standalone applications. All items were valid because they obtained the impact score

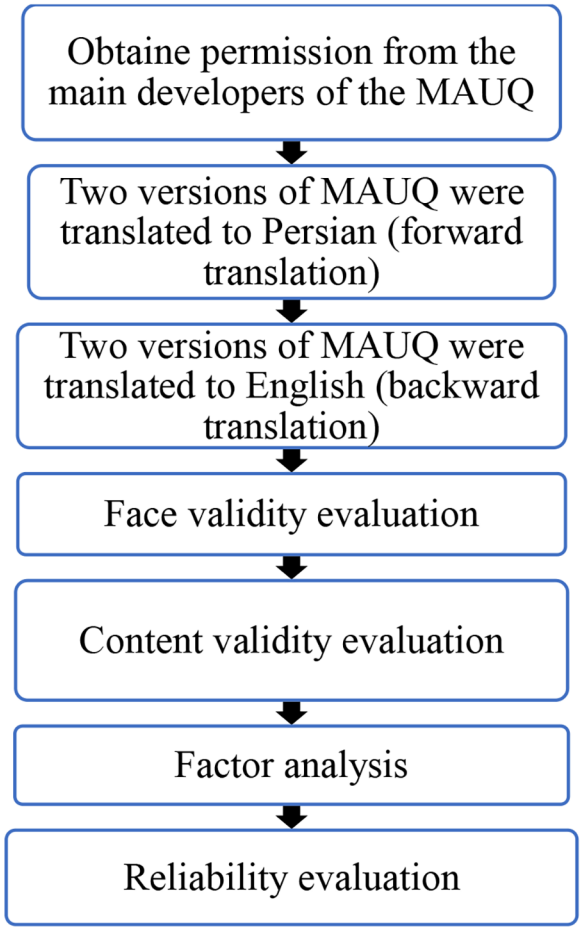

Fig. 1 The methodology of the study

more than 2.40 for face validity and the modified Kappa (k*) value more than 0.66 for content validity.

Table 2 shows the face and content validity of the Persian version of the MAUQ for interactive applications. All items were valid because they obtained the impact score more than 2.40 for face validity and the modified Kappa (k*) value more than 0.79 for content validity.

Totally 98 nurses (48 female and 50 male) were included in this study for factor analysis. The mean age of the participants was 21 years. The participants had average of 1.76 years of work experience (Table 3).

The Kaiser-Meyer-Olkin (KMO) value was 0.9 and Bartlett's test of sphericity was <0.001 that shows the adequacy of samples for factor analysis.

Factor analysis of Persian version of the MAUQ for standalone applications showed two factors (Table 4). The variance interpretation rates of the two factors for standalone applications were 40.90%, 30.79%, respectively, and the cumulative variance interpretation rate after rotation was 71.70%.

Factor analysis of Persian version of the MAUQ for interactive applications showed three factors (Table 5). The variance interpretation rates of the three factors for interactive applications were 34.31%, 22.50%, and 14.65%, respectively, and the cumulative variance interpretation rate after rotation was 71.47%.

The Cronbach's alpha of questionnaire for standalone applications was 0.96. The Cronbach's alpha for "Easy to use and usefulness" and "User interface and satisfaction" factors was 0.95, 0.93 respectively.

The Cronbach's alpha of questionnaire for interactive applications was 0.96. The Cronbach's alpha for "User interface and satisfaction", Usefulness, and "Easy to use" factors was 0.95, 0.93, 0.78 respectively.

The Persian version of MAUQ for standalone and interactive applications has been provided in Appendix A.

Moreover, the standalone version demonstrated no significant correlation between the demographic characteristics of the participants and factors 1 and 2, except for gender, which displayed a significant relationship with the scoring of both factor 1 and factor 2 ($Pvalue<0.05$), as presented in Appendix B Table 1.

Furthermore, the interaction version did not show any significant correlation between the participants' demographic characteristics and factors 1, 2, and 3. However, gender had an impact on the scoring of factor 1 and factor 2($Pvalue<0.05$), as revealed in Appendix B Table 2.

Discussion

This study detailed the process of translating and validating the English version of mHealth App Usability Questionnaire (MAUQ) into the Persian language. Our research revealed that MAUQ (both standalone and interaction for healthcare provider) had a high degree of face and content validity. The face validity (impact score$\geq$2.40) and the content validity (k*$\geq$0.66) was high for all individual items. Moreover, the adequacy of sampling was demonstrated by the Kaiser-Meyer-Olkin (KMO) value of 0.9 and the Bartlett's test of sphericity result of <0.001. The Cronbach's α coefficient for the total domains of MAUQ stand alone and interaction was greater than 0.90, indicating high reliability. For standalone applications, two factors, "Easy to use and usefulness" and "User interface and satisfaction," were identified, differing somewhat from the original MAUQ due to specific usability needs of nursing professionals. Meanwhile, interaction applications revealed three factors similar to the MAUQ: "User interface and satisfaction," "Usefulness," and "Easy to use." Gender emerged as the only significant demographic factor influencing responses.

As it mentioned in this study, the factor analysis for standalone applications revealed two factors with acceptable Cronbach's α coefficient and we labeled

Table 1 The face and content validity of Persian version of the MAUQ for standalone applications

Item	Impact score	K*
I1: The app was easy to use.	4.05(acceptable)	0.89(excellent)
I2: It was easy for me to learn how to use this app	3.44(acceptable)	0.89(excellent)
I3: The navigations were consistent when moving between the app's screens.	3.87(acceptable)	0.89(excellent)
I4: The interface of this app gave me the possibility to use all provided features (such as entering information, response to reminders, viewing information)	2.87(acceptable)	0.89(excellent)
I5: Whenever I made a mistake in using the app, I could correct my mistake easily and quickly.	3.44(acceptable)	0.89(excellent)
I6: I like the interface of the app.	3.36(acceptable)	1(excellent)
I7: Information in the app was well organized; therefore, I could easily find the information I needed.	3.78(acceptable)	0.79(excellent)
I8: This application has confirmed and provided enough information for me to know about the progress of my activity.	3.28(acceptable)	0.79(excellent)
I9: I feel comfortable using this app in public.	3.36(acceptable)	1(excellent)
I10: The time required to use this application was suitable for me.	3.96(acceptable)	0.66(good)
I11: I will use this app again.	2.40(acceptable)	0.89(excellent)
I12: Overall, I am satisfied with this app.	2.80(acceptable)	1(excellent)
I13: This app will be useful for my healthcare practice.	2.80(acceptable)	0.79(excellent)
I14: This app improved my access to provide healthcare services.	2.46(acceptable)	0.79(excellent)
I15: This app helped me manage my patients' health effectively.	2.87(acceptable)	0.66(good)
I16: This app has all the features and functions that I expected.	2.87(acceptable)	0.79(excellent)
I17: I could use this app even when the internet was weak or not connected.	3.44(acceptable)	0.79(excellent)
I18: This app provides an acceptable way to receive healthcare services such as accessing educational materials, tracking my activities, and performing self-assessments.	2.94(acceptable)	0.79(excellent)

Table 2 The face and content validity of Persian version of the MAUQ for interactive applications

Items	Impact score	K*
I1: The app was easy to use.	4.14(acceptable)	0.89(excellent)
I2: It was easy for me to learn how to use this app.	3.60(acceptable)	0.89(excellent)
I3: I like the interface of the app.	2.73(acceptable)	0.79(excellent)
I4: Information in the app was well organized; therefore, I could easily find information I needed.	3.52(acceptable)	0.89(excellent)
I5: I feel comfortable using this app in public.	2.52(acceptable)	1(excellent)
I6: The time required to use this application was suitable for me.	3.44(acceptable)	0.89(excellent)
I7: I will use this app again.	4.05(acceptable)	1(excellent)
I8: Overall, I am satisfied with this app.	3.96(acceptable)	0.89(excellent)
I9: Whenever I made a mistake in using the app, I could correct my mistake easily and quickly.	3.44(acceptable)	0.79(excellent)
I10: This application provides an acceptable way to provide healthcare services.	3.44(acceptable)	1(excellent)
I11: This application has confirmed and provided enough information for me to know about the progress of my activity.	3.60(acceptable)	0.79(excellent)
I12: When moving between the screens of the application, the navigation was consistent fixed.	3.36(acceptable)	0.89(excellent)
I13: The interface of this app gave me the possibility to use all provided feature (such as entering information, response to reminders, viewing information)	3.52(acceptable)	0.89(excellent)
I14: This app has all the features and functions that I expected.	2.87(acceptable)	0.89(excellent)
I15: This app will be useful for my healthcare practice.	3.01(acceptable)	0.89(excellent)
I16: This app improved my access to provide healthcare services.	4.05(acceptable)	0.79(excellent)
I17: This app helped me manage my patients' health effectively.	3.52(acceptable)	0.79(excellent)
I18: This app made it easy for me to communicate with my patients.	2.87(acceptable)	0.79(excellent)
I19: I had many more opportunities to communicate with my patients using this app.	2.40(acceptable)	0.79(excellent)
I20: I was confident that any information I sent to my patients using this application would be received.	2.80(acceptable)	0.79(excellent)
I21: I felt comfortable communicating with my patients using this application.	3.96(acceptable)	0.79(excellent)

them as "Easy to use and usefulness", and "User interface and satisfaction". The factors of our questionnaire are similar to the original MAUQ, which had only three factors (subscales), and we only merged them in different groups, namely "Easy to use and usefulness" and "User interface and satisfaction". The variation from the original questionnaire could be associated with the category of users employing particular applications for nursing services support, as they possess distinct usability prerequisites to access the accurate information they require [15]. On the other hand, the study participants were specific to nursing support services, which may

Table 3 Demographic information of the participants

Demographic information		Frequency (%)
Gender	Female	48 (49)
	Male	50 (51)
Age	19–24 years	94 (96)
	25–29 years	2 (2)
	30–35 years	2 (2)
Work experience	1–6 years	96 (98)
	7–12 years	2 (2)

have different usability requirements than the original MAUQ's participants. This distinction may explain the variations in identified factors, as noted in prior research. For instance, Saparamadu et al. [24], found that healthcare professionals have distinct usability expectations compared to general users, often necessitating tailored app designs to address their unique challenges. Moreover, the standalone applications evaluated in this study may have had different features and functionalities than those evaluated in the original MAUQ, resulting in different factors being identified. Therefore, the divergence from the original MAUQ structure may also reflect the particular functionalities and features of the standalone applications evaluated in this study. Studies have shown that the usability of mHealth apps is closely tied to their design and functional offerings, which vary significantly across applications and user groups [25]. For example, applications tailored for nursing support may emphasize streamlined workflows and accurate data presentation, differing from the needs of a broader user base.

Moreover, the study was conducted in a different cultural context than the original MAUQ, which could have resulted in different user expectations and requirements. Cultural context is another critical factor influencing usability perceptions. Hofstede's cultural dimensions theory has long established that cultural norms shape user expectations and interactions with technology [26]. In our study, the cultural and healthcare setting of Persian-speaking users likely influenced their preferences and usability requirements. This aligns with findings from studies by Gonzalez et al. [27], which report that cultural differences play a significant role in shaping health app usability and adoption. As a result, the factors identified in the study may not be entirely similar to the original questionnaire. The variations observed in the standalone application factors underscore the importance of context-specific usability evaluations. mHealth app developers should consider these nuances to create more adaptable and targeted usability tools, ensuring relevance across diverse user groups and cultural contexts.

Moreover, the exploratory Factor Analysis for interaction applications in this study revealed three factors with an acceptable Cronbach's α coefficient, which were labeled as "User interface and satisfaction", "Usefulness" and "Easy to use". These factors of our questionnaire were similar to the original MAUQ questionnaire [1].

Table 4 Factor analysis of the Persian version of MAUQ for standalone applications

Item of the Persian version	Factor loadings	
	Factor 1 (Easy to use and usefulness)	Factor 2 (User interface and satisfaction)
I1: The app was easy to use.	**0.720**	0.442
I2: It was easy for me to learn how to use this app.	**0.710**	0.404
I3: The navigations were consistent when moving between the app's screens.	**0.803**	0.319
I4: The interface of this app gave me the possibility to use all provided features (such as entering information, response to reminders, viewing information).	**0.774**	0.419
I12: Overall, I am satisfied with this app.	**0.586**	0.478
I13: This app will be useful for my healthcare practice.	**0.699**	0.470
I14: This app improved my access to provide healthcare services.	**0.737**	0.444
I15: This app helped me manage my patients' health effectively.	**0.814**	0.368
I16: This app has all the features and functions that I expected.	**0.743**	0.368
I17: I could use this app even when the internet was weak or not connected.	**0.764**	0.134
I18: This app provides an acceptable way to receive healthcare services such as accessing educational materials, tracking my activities, and performing self-assessments.	**0.693**	0.460
I5: Whenever I made a mistake in using the app, I could correct my mistake easily and quickly.	0.461	**0.683**
I6: I like the interface of the app.	0.560	**0.662**
I7: Information in the app was well organized; therefore, I could easily find the information I needed.	0.520	**0.647**
I8: This application has confirmed and provided enough information for me to know about the progress of my activity.	0.488	**0.749**
I9: I feel comfortable using this app in public.	0.115	**0.908**
I10: The time required to use this application was suitable for me.	0.383	**0.779**
I11: I will use this app again.	0.502	**0.668**

Table 5 Factor analysis of the Persian version of MAUQ for interactive applications

Item of the Persian version	Factor loadings		
	Factor 1 (User interface and satisfaction)	Factor 2 (Usefulness)	Factor 3 (Easy to use)
I3: I like the interface of the app.	**0.548**	0.262	0.532
I6: The time required to use this application was suitable for me.	**0.673**	0.347	0.487
I7: I will use this app again.	**0.622**	0.398	0.366
I8: Overall, I am satisfied with this app.	**0.595**	0.505	0.088
I9: Whenever I made a mistake in using the app, I could correct my mistake easily and quickly.	**0.695**	0.225	0.364
I10: This application provides an acceptable way to provide healthcare services.	**0.780**	0.250	0.175
I11: This application has confirmed and provided enough information for me to know about the progress of my activity.	**0.726**	0.299	0.221
I12: When moving between the screens of the application, the navigation was consistent fixed.	**0.728**	0.218	0.304
I13: The interface of this app gave me the possibility to use all provided feature (such as entering information, response to reminders, viewing information)	**0.667**	0.248	0.386
I14: This app has all the features and functions that I expected.	**0.812**	0.328	0.114
I15: This app will be useful for my healthcare practice.	**0.753**	0.284	0.332
I16: This app improved my access to provide healthcare services.	**0.615**	0.549	0.053
I17: This app helped me manage my patients' health effectively.	0.589	**0.653**	-0.059
I18: This app made it easy for me to communicate with my patients.	0.307	**0.764**	0.349
I19: I had many more opportunities to communicate with my patients using this app.	0.288	**0.825**	0.228
I20: I was confident that any information I sent to my patients using this application would be received.	0.197	**0.880**	0.256
I21: I felt comfortable communicating with my patients using this application.	0.238	**0.849**	0.267
I1: The app was easy to use.	0.019	0.245	**0.629**
I2: It was easy for me to learn how to use this app.	0.511	0.211	**0.672**
I4: Information in the app was well organized; therefore, I could easily find information I needed.	0.581	0.078	**0.595**
I5: I feel comfortable using this app in public.	0.543	0.161	**0.566**

These identified factors align closely with those found in the original MAUQ questionnaire, suggesting a consistent structure across different cultural contexts and languages. The congruence of these factors with the original MAUQ highlights the robustness and reliability of the questionnaire's design, ensuring that it effectively captures key aspects of mHealth app usability regardless of the user group. Anders et al. [28], reported similar findings, indicating that the MAUQ consistently identifies these three core usability factors. This consistency underscores the universal applicability of the MAUQ in assessing mHealth app usability, making it a valuable tool for researchers and developers globally. Aditionally, other similar findings have been reported in studies such as Gagnon et al. [29], which demonstrated that usability factors like ease of use and user satisfaction consistently emerge across mHealth usability assessments, regardless of language or cultural differences. Likewise, a study by Alsswey et al. [30], noted that these dimensions are critical in determining the success and user acceptance of mHealth apps in diverse healthcare settings, reinforcing their inclusion as core factors in usability tools.

This alignment suggests that the MAUQ's structural design effectively captures fundamental aspects of mHealth usability that transcend cultural boundaries. The robust and replicable nature of these factors has been corroborated in various studies, such as those by Wang et al. [31], which highlighted the adaptability of the MAUQ for evaluating usability in different regions and among varied healthcare user groups. Furthermore, Gao et al. [32], confirmed the questionnaire's reliability in assessing usability within clinical applications, underscoring its versatility in healthcare technology evaluation. The congruence of these factors with the original MAUQ highlights the questionnaire's potential as a standard measure for cross-cultural usability assessments. As Deniz-Garcia et al. [33], observed, standardized tools like the MAUQ can facilitate international comparisons, enabling developers and researchers to benchmark usability features and identify areas for improvement in mHealth technologies globally. These findings support the MAUQ's value as a foundational tool for usability research and its applicability to diverse user populations. Therefore, by demonstrating consistency in usability dimensions across studies, our findings reaffirm the validity and reliability of the MAUQ as a globally relevant instrument for assessing mHealth app usability. This global applicability ensures that the tool remains an essential resource for guiding the development of user-friendly and effective mHealth solutions.

Our findings indicate that, aside from gender, there was no significant association between the provider' other

demographic information and the questionnaire's factors. This implies that a nurse's gender may play a crucial role in influencing their responses to the questionnaire. These findings of the study align with prior research emphasizing the significance of gender in shaping attitudes and experiences related to health [8]. Men and women may have different health behaviors, beliefs, and attitudes that could influence their responses to the questionnaire. Previous research has underscored the influence of gender on health-related behaviors and attitudes, demonstrating that men and women often approach health technologies differently [34]. For example, women are generally more proactive in seeking health-related information and engaging with mobile health apps, which may reflect greater health awareness and a more preventative approach to care [35]. This proactive behavior could explain why female respondents in our study exhibited distinct usability patterns.

In contrast, men are typically less likely to engage with health applications or may use them for different purposes, such as fitness tracking, rather than holistic health management [36]. Furthermore, women may encounter unique barriers to accessing or using health apps, such as technological challenges or socio-cultural constraints, which could also shape their app usage experiences [37]. Conversely, men might demonstrate differing attitudes toward app features related to self-care, such as dietary tracking or exercise management, potentially leading to varied usability perceptions. These gender-based distinctions highlight the necessity for health app developers to adopt a more tailored approach, considering gender-specific needs and preferences during design and implementation. Future research with larger, more diverse samples could further elucidate how gender influences app usability, providing critical insights to enhance mHealth app development and adoption strategies.

Future recommendations and practical suggestions

Future studies should use larger and more diverse samples to test the generalizability of our findings. Including participants from various healthcare roles and demographic backgrounds will provide more comprehensive insights. Additionally, conducting longitudinal studies to assess how gender influences the long-term use and effectiveness of mHealth apps can provide valuable data for developers and policymakers. Further research should focus on context-specific factors that influence the usability of mHealth apps in different cultural and healthcare settings. This approach will help in developing more targeted and effective mHealth solutions. Additionally, comparative studies between different versions of the MAUQ and other usability questionnaires can help refine these tools and ensure their relevance across various applications and user groups. By addressing these practical suggestions and future recommendations, healthcare professionals and developers can enhance the usability and effectiveness of mHealth apps, ensuring they cater to the diverse needs of healthcare providers.

Moreover, healthcare organizations should integrate gender-sensitive approaches when developing and implementing mHealth apps. Understanding the different needs and barriers faced by male and female providers can improve app usability and adoption rates. Providing tailored training programs for male and female nurses on the use of mHealth apps can help bridge the usability gap and enhance their effectiveness in clinical settings. Additionally, developers should consider cultural differences when designing mHealth apps to ensure they meet the specific needs and expectations of users in different regions. Conducting regular usability testing with diverse user groups, including both genders and various cultural backgrounds, can help identify and address usability issues promptly. These efforts will collectively contribute to more inclusive and effective mHealth solutions that better serve the healthcare community.

Limitation of the study

This study has several limitations. First, the sampling of nurses from a single city, which makes it difficult to generalize the results to the entire Iranian population. The recruitment of only nurses also decreased the results less convincing. Additionally, the sample size was too small to ensure the generalization of the findings.

Conclusion

In this study, the psychometric assessment of the provider version of the MAUQ in Persian was conducted. The findings of this study confirm that the Persian version of the MAUQ is a reliable and valid tool for assessing mHealth app usability. The scale exhibited strong psychometric properties, including high face and content validity, robust reliability, and the identification of key usability dimensions, namely "Ease of Use and Usefulness" and "User Interface and Satisfaction," which align well with the needs of Persian-speaking healthcare professionals. These findings highlight the applicability of the MAUQ in assessing and improving mHealth solutions for Persian-speaking healthcare professionals, establishing a foundation for tailoring the tool to address specific usability needs in this population. Moreover, by addressing usability dimensions such as "Ease of Use and Usefulness" and "User Interface and Satisfaction," the MAUQ provides valuable insights for improving the design, adoption, and effectiveness of mHealth applications in healthcare environments.

For future research, extending the validation of the MAUQ to other languages and cultural contexts would broaden its applicability and relevance. Conducting

criterion-related validation studies is also recommended to establish the tool's predictive power against other usability measures or domains, which could further enhance its robustness. Additionally, future studies should investigate the usability of interactive and standalone mHealth apps designed for patients, applying targeted usability assessments to evaluate the MAUQ's suitability for these app types. This approach may provide valuable insights into optimizing mHealth usability for patient-centered care, supporting improved adoption and outcomes across diverse patient populations.

Abbreviations

MAUQ	mHealth App Usability Questionnaire
PSSUQ	Post-Study System Usability Questionnaire
SUS	System Usability Scale
CVI	content validity index
KMO	Kaiser-Meyer-Olkin

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Author contributions
S.HG, A.Sh and Kh.M were responsible for concept and design, methodology and interpretation of data. S.HG, Kh.M and F.D extracted the data and performed the analysis. S.HG, A.Sh and Kh.M drafted the manuscript and created tables. A.Sh, J.F and K.B reviewed the manuscript. All approved the final version of the manuscript. All authors meet the criteria detailed in Author Instructions.

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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
The study was approved by ethical committee of Kerman University of Medical Sciences. The Ethic approval Code is IR.KMU.REC.1401.518. All methods were performed in accordance with the relevant guidelines and regulations. Informed consent was obtained from all subjects.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. Zhou L, Bao J, Setiawan IMA, Saptono A, Parmanto B. The mHealth App Usability Questionnaire (MAUQ): Development and Validation Study. JMIR mHealth uHealth. 2019;7(4):e11500.
2. Moulaei K, Sheikhtaheri A, Ghafaripour Z, Bahaadinbeigy K. The Development and Usability Assessment of an mHealth Application to Encourage Self-Care in Pregnant Women against COVID-19. *Journal of Healthcare Engineering* 2021, 2021:9968451.
3. Moulaei K, Bahaadinbeigy K, Ghaffaripour Z, Ghaemi MM. The design and evaluation of a Mobile based application to Facilitate Self-care for pregnant women with Preeclampsia during COVID-19 prevalence. J Biomedical Phys Eng. 2021;11(4):551–60.
4. Mustafa N, Safii NS, Jaffar A, Sani NS, Mohamad MI, Abd Rahman AH, Mohd Sidik S. Malay version of the mHealth App Usability Questionnaire (M-MAUQ): translation, adaptation, and Validation Study. JMIR Mhealth Uhealth. 2021;9(2):e24457.
5. Sarkar U, Gourley GI, Lyles CR, Tieu L, Clarity C, Newmark L, Singh K, Bates DW. Usability of commercially available mobile applications for diverse patients. J Gen Intern Med. 2016;31(12):1417–26.
6. Nayebi F, Desharnais J-M, Abran A. The state of the art of mobile application usability evaluation. In: 2012 *25th IEEE Canadian Conference on Electrical and Computer Engineering (CCECE): 2012*: IEEE; 2012: 1–4.
7. Hajesmaeel-Gohari S, Khordastan F, Fatehi F, Samzadeh H, Bahaadinbeigy K. The most used questionnaires for evaluating satisfaction, usability, acceptance, and quality outcomes of mobile health. BMC Med Inf Decis Mak. 2022;22(1):22.
8. Shan Y, Ji M, Xie W, Li R, Qian X, Zhang X, Hao T. Chinese version of the Mobile Health App Usability Questionnaire: translation, adaptation, and Validation Study. JMIR Form Res. 2022;6(7):e37933.
9. Moulaei K, Moulaei R, Bahaadinbeigy K. The most used questionnaires for evaluating the usability of robots and smart wearables: a scoping review. Digit Health. 2024;10:20552076241237384.
10. Moulaei K, Sheikhtaheri A, Ghafaripour Z, Bahaadinbeigy K. The development and usability assessment of an mhealth application to encourage self-care in pregnant women against COVID-19. J Healthc Eng. 2021;2021(1):9968451.
11. Nurgalieva L, O'Callaghan D, Doherty G. Security and privacy of mHealth applications: a scoping review. IEEE Access. 2020;8:104247–68.
12. Hensher M, Cooper P, Dona SWA, Angeles MR, Nguyen D, Heynsbergh N, Chatterton ML, Peeters A. Scoping review: development and assessment of evaluation frameworks of mobile health apps for recommendations to consumers. J Am Med Inform Assoc. 2021;28(6):1318–29.
13. Tacke T, Nohl-Deryk P, Lingwal N, Reimer LM, Starnecker F, Güthlin C, Gerlach FM, Schunkert H, Jonas S, Müller A. The German version of the mHealth app usability questionnaire (GER-MAUQ): translation and validation study in patients with cardiovascular disease. Digit Health. 2024;10:20552076231225168.
14. Zhao S, Cao Y, Cao H, Liu K, Lv X, Zhang J, Li Y, Davidson PMJFP. Chinese version of the mHealth app usability questionnaire: Cross-cultural adaptation and validation. 2022, 13:813309.
15. Quifer-Rada P, Aguilar-Camprubí L, Gómez-Sebastià I, Padró-Arocas A, Mena-Tudela D. Spanish version of the mHealth app usability questionnaire (MAUQ) and adaptation to breastfeeding support apps. Int J Med Informatics. 2023;174:105062.
16. Sousa VD, Rojjanasrirat W. Translation, adaptation and validation of instruments or scales for use in cross-cultural health care research: a clear and user-friendly guideline. J Eval Clin Pract. 2011;17(2):268–74.
17. Zamanzadeh V, Ghahramanian A, Rassouli M, Abbaszadeh A, Alavi-Majd H, Nikanfar A-R. Design and implementation content validity study: development of an instrument for measuring patient-centered communication. J Caring Sci. 2015;4(2):165–78.
18. Polit DF, Beck CT, Owen SV. Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. Res Nurs Health. 2007;30(4):459–67.
19. Cicchetti DV, Sparrow SA. Developing criteria for establishing interrater reliability of specific items: applications to assessment of adaptive behavior. Am J Ment Defic. 1981;86(2):127–37.
20. Zamanzadeh V, Ghahramanian A, Rassouli M, Abbaszadeh A, Alavi-Majd H, Nikanfar A-R. Design and implementation content validity study: development of an instrument for measuring patient-centered communication. J Caring Sci. 2015;4(2):165.
21. Pett M. Making sense of factor analysis: The use of factor analysis for instrument development in health care research. *Thousand Oaks* 2003.

22. Costello AB, Osborne J. Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis. Practical Assess Res Evaluation. 2019;10(1):7.
23. Cronbach LJ. Coefficient alpha and the internal structure of tests. Psychometrika. 1951;16(3):297–334.
24. Saparamadu AADNS, Fernando P, Zeng P, Teo H, Goh A, Lee JMY, Lam CWL. User-centered design process of an mHealth app for health professionals: Case study. JMIR mHealth uHealth. 2021;9(3):e18079.
25. Alam MZ, Hoque MR, Hu W, Barua Z. Factors influencing the adoption of mHealth services in a developing country: a patient-centric study. Int J Inf Manag. 2020;50:128–43.
26. Hofstede G. Culture's consequences: Comparing values, behaviors, institutions and organizations across nations. Thousand Oaks 2001.
27. Gonzalez C, Early J, Gordon-Dseagu V, Mata T, Nieto C. Promoting culturally tailored mHealth: a scoping review of mobile health interventions in latinx communities. J Immigr Minor Health. 2021;23(5):1065–77.
28. Anders C, Moorthy P, Svensson L, Müller J, Heinze O, Knaup P, Wallwiener M, Deutsch TM, Le T-V, Weinert L. Usability and user experience of an mHealth app for Therapy support of patients with breast Cancer: mixed methods study using Eye Tracking. JMIR Hum Factors. 2024;11:e50926.
29. Gagnon J, Probst S, Chartrand J, Lalonde M. mHealth app usability questionnaire for stand-alone mHealth apps used by health care providers: Canadian French translation, cross-cultural adaptation, and validation (part 1). JMIR Formative Res. 2024;8:e50839.
30. Alsswey AH, Al-Samarraie H, El-Qirem FA, Alzahrani AI, Alfarraj O. Culture in the design of mHealth UI: an effort to increase acceptance among culturally specific groups. Electron Libr. 2020;38(2):257–72.
31. Wang Y, Chai J, Lei T, Chinese UMUX. Cross-cultural adaptation for perceived usability measurement. Int J Human–Computer Interact. 2021;37(16):1538–50.
32. Gao M, Kortum P, Oswald F. Psychometric evaluation of the USE (usefulness, satisfaction, and ease of use) questionnaire for reliability and validity. In: *Proceedings of the human factors and ergonomics society annual meeting: 2018*: Sage Publications Sage CA: Los Angeles, CA; 2018: 1414–1418.
33. Deniz-Garcia A, Fabelo H, Rodriguez-Almeida AJ, Zamora-Zamorano G, Castro-Fernandez M, Alberiche Ruano MP, Solvoll T, Granja C, Schopf TR, Callico GM. Quality, usability, and effectiveness of mHealth apps and the role of artificial intelligence: current scenario and challenges. J Med Internet Res. 2023;25:e44030.
34. Galdas PM, Cheater F, Marshall P. Men and health help-seeking behaviour: literature review. J Adv Nurs. 2005;49(6):616–23.
35. Javanmardi M, Noroozi M, Mostafavi F, Ashrafi-Rizi H. Internet usage among pregnant women for seeking health information: a review article. Iran J Nurs Midwifery Res. 2018;23(2):79–86.
36. Zhang X, Guo X, Lai K-h, Guo F, Li C. Understanding gender differences in m-health adoption: a modified theory of reasoned action model. Telemedicine e-Health. 2014;20(1):39–46.
37. Moulaei K, Moulaei R, Bahaadinbeigy K. Barriers and facilitators of using health information technologies by women: a scoping review. BMC Med Inf Decis Mak. 2023;23(1):176.

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