Determinants of nurses' continuance intention to use mobile health applications in clinical nursing practices: An extension to the Expectation-Confirmation Model

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Abstract

Background: Mobile health (mHealth) applications offer valuable tools for clinical nursing practice, improving access to medical resources and enhancing patient care. However, understanding the factors that influence nurses' intention to continue using these technologies is crucial for ensuring long-term adoption

Objective: This study extends the Expectation-Confirmation Model (ECM) to explore the determinants of Iranian nurses' continuance intention to use mHealth applications in their daily clinical routines.

Methods: A cross-sectional, descriptive-analytical study was conducted among 315 nurses from hospitals affiliated with Kashan University of Medical Sciences. Participants completed structured questionnaires measuring variables including perceived usefulness, perceived ease of use, social influence, habits, and technology anxiety. Data were analyzed using structural equation modeling (SEM) through AMOS software (version 26). The model tested relationships among confirmation, perceived usefulness, social influence, technology anxiety, and mHealth continuance behavior

Results: The analysis revealed that perceived usefulness was significantly influenced by both confirmation ($p < 0.001$) and social influence ($p < 0.001$). Perceived ease of use was negatively impacted by new technology anxiety ($p < 0.001$), indicating that higher anxiety levels reduced perceived ease of use. Additionally, mHealth continuance behavior was positively associated with habits ($p = 0.002$), social influence ($p < 0.001$), and perceived security risks ($p = 0.008$). Contrary to expectations, perceived usefulness did not directly influence mHealth continuance ($p = 0.151$), suggesting that other factors, such as habits and social influence, play a more significant role in long-term use.

Conclusions: The findings highlight the importance of perceived social influence and the confirmation of initial expectations in encouraging nurses to continue using mHealth applications. While perceived usefulness is traditionally considered a key driver in technology adoption, this study indicates that habits and social influence are more crucial in sustaining mHealth use over time. Furthermore, new technology anxiety remains a significant barrier, suggesting that interventions should focus on reducing apprehension through training and support. Hospital managers and healthcare leaders should consider these factors when developing strategies to integrate mHealth technologies into nursing workflows, as well as create environments that foster

positive social reinforcement and minimize security concerns. This study provides critical insights for improving the implementation of digital health tools in nursing practice, ultimately leading to enhanced patient care and more efficient clinical operations.

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Determinants of nurses' continuance intention to use mobile health applications in clinical nursing practices: An extension to the Expectation-Confirmation Model

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Abstract
background: Mobile health (mHealth) applications offer valuable tools for clinical nursing practice, improving access to medical resources and enhancing patient care. However, understanding the factors that influence nurses' intention to continue using these technologies is crucial for ensuring long-term adoption.
Objective: This study extends the Expectation-Confirmation Model (ECM) to explore the determinants of Iranian nurses' continuance intention to use mHealth applications in their daily clinical routines.
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Keywords: Continuance intention, perceived usefulness, Expectation–Confirmation Model, mobile health, technology anxiety, habits, satisfaction

Introduction

Clinical nurses are responsible for various care interventions, such as administering prescribed medications, taking vital signs, changing wound dressings, and providing supportive and educational interventions to patients (1). In this context, smartphones offer a new opportunity to improve the quality of care (2). The use of smartphones in nursing offers several benefits, such as reducing medication errors, improving time management and communication (3), implementing effective cost-saving strategies (4), and improving the quality of education (5, 6). According to one study (2021), approximately 80% of nurses use their smartphones in the workplace for personal and professional purposes, using them as useful tools to improve the quality of care (7). Another study conducted in 2018 reported that approximately 62.4% of nursing students use smartphones, with the most commonly used technological resources being medical dictionaries, anatomical atlases, and nursing care guides (8).

Many hospitals are in the process of developing policies regarding the use of smartphones by healthcare providers in the clinical setting. However, several studies suggest that nurses may face challenges in accurately determining the appropriateness of smartphone use in the workplace, which may lead to clinical complications (9). Many studies have examined the continued use of smartphones by users (10-12). However, these studies have been criticized for their different methodologies and lack of consistency in prioritizing factors related to smartphone use in care teams (13, 14). For example, the study by Muqtadiroh et al. (2019) revealed a direct relationship between perceived usefulness and continuance using factors (15), whereas another study in 2019 refuted this relationship (16). In contrast, the study by Lew et al. (2019) revealed a positive correlation between perceived ease of use and continuance-using factors (17). However, another study (2016) does not support this hypothesis (18).

In the context of technology adoption, continuous use is often associated with the cognitive process of post-adoption behavior. This involves the conscious evaluation of technology tools during their use (19). A prominent theory often used in research on continuance intention is the expectation-confirmation model (ECM). The theoretical framework proposed by Bhattacherjee has received considerable attention in technology acceptance and continuance research (20, 21). The ECM examines the relationships among confirmation, perceived usefulness, and user satisfaction with continuance using the factor (22). Due to the lack of similar studies on nurses in Iran, the inconsistent findings of previous research, and the strengths of the ECM in elucidating behavioral intentions, the present study was designed and conducted to investigate the factors influencing the intention to continue using mHealth application among nurses in Kashan, with a special focus on the ECM.

Materials and methods

Study design and participants

The present cross-sectional study was conducted between March and September 2022 in six hospitals affiliated with Kashan University of Medical Sciences. To determine the sample size for structural equation modeling (SEM), Kline suggested that 5-10 samples per item are sufficient to assess the model fit (23). Given the 33-item scale developed by Field et al. (2022) (24), 315 clinical nurses were considered the sample size. Nurses were selected using systematic sampling. In addition, proportional allocation was used to ensure that the number of samples selected from each hospital was proportional to the population of nurses in that specific hospital. Sample selection was based on the list provided by the education department of each hospital. In cases where the selected nurses were unavailable or uncooperative, another nurse was randomly replaced (based on the random numbers table).

Inclusion criteria included having at least six months of work experience in clinical wards and use of least one technology tool in nursing. Exclusion criteria included failure to complete the data collection scales and withdrawal from further cooperation. After data collection, each scale received was systematically checked for errors, incompleteness, and unanswered items. To ensure the validity of the analysis and an appropriate representation of the data, scales that contained unanswered items or where the response "no comment" was used for all items were excluded from the data analysis. Finally, 368 samples with scales were completed, and after the screening process, 315 samples were considered for data analysis.

Data collection scales

The data collection scales included the Nurses' Mobile Health Device Acceptance Scale questionnaire and the intention to continue using the mobile health application for nurses questionnaire.

Nurses’ Mobile Health Device Acceptance Scale (NMHDA-Scale) was developed by Mirabootalebi et al. in 2022 (24). This questionnaire was designed based on the ECM and Waltz's approach (25). This questionnaire aimed to identify the influential factors based on the ECM. Previous studies have not focused specifically on clinical nurses and have shown inconsistent relationships between factors. The questionnaire comprises ten domains, including Perceived Security Risk (PS), New Technology Anxiety (AN), Social Influence (SI), Perceived Ease of Use (EU), Confirmation (CO), m-health Continuance (MHC), Maturity (MA), Perceived Usefulness (PU), Habits (HA), and User Satisfaction (SA). The reliability of the questionnaire was assessed via Cronbach's alpha and McDonald's omega coefficients, which were estimated to be 0.877 and 0.879, respectively (24).

The Intention to Continue Using Mobile Health Applications for Nurses questionnaire is designed to measure nurses' willingness to continue using Mobile Health Applications for nursing care in the future. It also includes the willingness to use these tools, efforts to improve nursing care with smartphones, and strategies to integrate them into nursing services. The score of this questionnaire is calculated based on the average score of three items. Internal consistency was confirmed via Cronbach's alpha coefficient, combined reliability (CR), and average variance extracted (AVE) to assess discriminant and convergent validity. The Cronbach's alpha coefficient was greater than 0.8. In this study, a 5-point Likert scale was used to rate each item, with each item receiving a score between 1 and 5.

Research model

To gain a comprehensive understanding of the post-implementation phase of continued use of information systems (IS continuance), this study develops an ECM research model to explore the key factors that influence the continued use of mobile health (m-health) in Iran. This model combines Bhattacharjee's ECM (20, 21) and the model development by other similar studies (14, 26-30). Considering that the relevant literature focuses mainly on the physician population and the need to adapt the factors to the priorities of Iran and the effective personal, organizational, technical, and

social factors, the model was developed based on these criteria. The present study acknowledges Bhattacharjee's (2001) perspective, which offers a theoretical model of IS continuance that distinguishes between acceptance and continuation behaviors. This model draws parallels between people's IS continuance use decisions and their frequent purchase decisions using information and communication technology (ICT).

According to Figure 1, confirmation (CO) refers to the user's perception of the fit between the IS expectations and actual performance (14, 28). Maturity (MA) refers to the user's perception of the quality of the system and reflects the user's perceived level of satisfaction and the need to improve the system (14). Perceived usefulness (PU) is the extent to which a person believes that his or her job performance will improve with a particular system (14, 22). M-health continuance (MHC) represents the user's intention to continue using technology tools (14). Perceived ease of use (EU) is the extent to which a person intends to exert minimal physical and mental effort when using a particular system (29). Perceived security risk (PS) refers to the ability of a system to protect information from potential threats and to ensure protection from attacks that could compromise data and services (30). New technology anxiety (AN) refers to the fear of using new technologies (31). User satisfaction (SA) is considered an important component of the use and success of an IS (19). Social influence (SI) refers to the perceived social pressure that influences behavioral decisions (28). Finally, habits (HA) are proposed as important constructs that influence the continuation or discontinuation of technology use (19).

The hypotheses of this study are as follows:

Hypothesis 1: Confirmation (CO) is related to perceived usefulness (PU).
Hypothesis 2: Social influence (SI) is related to perceived usefulness (PU).
Hypothesis 3: New technology anxiety (AN) is related to perceived ease of use (EU).
Hypothesis 4: Perceived usefulness (PU) is related to m-health continuance (MHC).
Hypothesis 5: Habits (HA) are related to m-health continuance (MHC).
Hypothesis 6: Maturity (MA) is related to m-health continuance (MHC).
Hypothesis 7: Social influence (SI) is related to m-health continuance (MHC).
Hypothesis 8: Perceived security risk (PS) is related to m-health continuance (MHC).

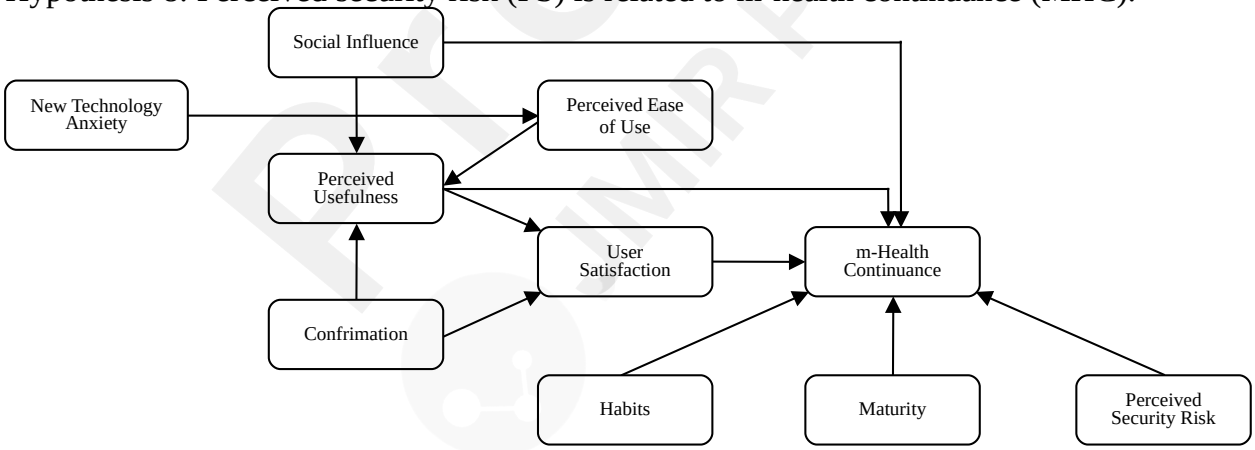


Figure 1. Structural model of the research

Data analysis

Data were analyzed using SPSS software version 26 and AMOS software version 24. Categorical variables are described as frequencies and percentages, whereas quantitative variables are summarized as the means and standard deviations (SDs). Correlations between variables were assessed using the Spearman-Brown correlation coefficient. SEM was used to examine the relationships between the variables influencing the continuous use of mobile health applications. In accordance with the theoretical model of the study, all variables were analyzed using AMOS

software to understand the relationships between the variables, and a structural model was developed. In this study, the Pearson correlation coefficient (R) and regression (R2) were used to determine the relationship between each research variable with a significance level of less than 0.05. The structural model test was conducted using path coefficients and R2 values. The R2 values indicate the percentage of the variability of the internal variables that can be explained by the external variables, thus demonstrating the predictive power of the model. In addition, model fit criteria were examined, including the root mean square error of approximation (RMSEA), comparative fit index (CFI), Tucker-Lewis index (TLI), chi-squared divided by degrees of freedom ($\chi 2/df$), incremental fit index (IFI), and goodness-of-fit index (GFI). Goodness of fit was indicated by critical values for $\chi 2/df$ of less than 3, CFI and TLI of 0.9 or greater, RMSEA of less than 0.9, and GFI and IFI of 0.90 or greater (33, 32).

Ethical considerations

The necessary approvals were obtained from the Ethics Committee and the Vice-Chancellor for Research and Technology of Kashan University of Medical Sciences (IR.KAUMS.NUHEPM.REC.1401.039). The clinical nurses provided consent to participate in the study after being informed about the objectives of the study, participation, right to withdraw, and anonymity of the data collected.

Results

Participants characteristics

In this study, 400 clinical nurses were examined. Finally, 315 samples were analyzed. The mean age of the nurses was 35.67 ± 1.24 years. Most of the samples analyzed were female (80%) and married (77.1%) (Supplementary Table).

Two-step path analysis approach

According to the questionnaire scoring, m-health continuance was rated as high. User satisfaction, perceived security risk, affirmation, habits, perceived usefulness, and maturity were all rated as average. In addition, perceived ease of use, social influence, and new technology anxiety received low scores (Table 2). Pearson's correlation coefficient revealed significant correlations between the variables studied (Table 3). Two-step path analysis (2S-PA) was used for SEM. In the first step, reliability assessment and confirmatory factor analysis (CFA) were performed. The internal consistency of the questionnaire was assessed by Cronbach's alpha, the CR, and the AVE and yielded values of 0.851, 0.892, and 0.63, respectively. These results indicate that the reliability of the questionnaire meets the acceptable thresholds for Cronbach's alpha (above 0.7), CR (above 0.7), and AVE (above 0.5). Therefore, the data were suitable for SEM and correlation analysis (Table 2).

Table 2. Means, standard deviations, reliabilities and validities of the model variables

Variables	Mean	SD	α	CR	AVE
Perceived Ease of Use	15.6	4.4	0.888	0.999	0.62
m-health Continuance	11.1	2.2	0.763	0.995	0.61
Maturity	9.6	2.6	0.908	0.981	0.61
Perceived Usefulness	10	2.2	0.763	0.817	0.60
Habits	9.6	2.8	0.818	0.821	0.60
Social n	21.5	4.4	0.875	0.791	0.52
New Technology Anxiety	13.3	2.2	0.878	0.991	0.63
Perceived Security Risk	9	2.76	0.901	0.922	0.75
Confirmation	9.6	2.5	0.861	0.872	0.75
User Satisfaction	9.5	2.5	0.855	0.722	0.61

SD: Standard Deviation, **α**: Cronbach's alpha, **CR**: Combined Reliability, **AVE**: Average Variance Extracted

Table 3. Correlation matrix of the model variables

	EU	SI	AN	HA	PS	CO	MA	PU	HC
SI	0.306*	1							
AN	0.699*	0.370*	1						
HA	0.692*	0.374*	0.716*	1					
PS	0.803*	0.362*	0.715*	0.681*	1				
CO	0.737*	0.370*	0.681*	0.660*	0.740*	1			
MA	0.738*	0.347*	0.659*	0.641*	0.697*	0.821*	1		
PU	0.654*	0.443*	0.602*	0.569*	0.652*	0.741*	0.794*	1	
MHC	0.323*	0.633*	0.337*	0.360*	0.220*	0.444*	0.430*	0.546*	1
SA	0.744*	0.334*	0.709*	0.643*	0.705*	0.860*	0.838*	0.781*	0.408*

***** p<0.001
EU: Perceived Ease of use, **SI**: Social Influence, **AN**: New Technology anxiety, **HA**: Habits, **PS**: Perceived Security risk, **CO**: Confirmation, **MA**: Maturity, **PU**: Perceived usefulness, **MHC**: M-health continuance, **SA**: User satisfaction.

A significance level of 0.05 or less was used to interpret and accept or reject the hypotheses. It can be concluded that all hypotheses except hypotheses 4 and 6 are confirmed. Importantly, a positive path coefficient indicates that the change in the two variables is in the same and direct direction. Conversely, a negative standard path coefficient indicates that both variables change in a negative way, and vice versa. In other words, when one variable increases, the other variable decreases, or when the independent variable increases, the dependent variable decreases (Table 4).

Table 4. Statistical assumptions related to the analysis of the measurement model

Hypothesis	Path	Path Coefficient		Critical Value	p value
		Standard	non-Standard		
1	PU → CO	0.895	0.852	13.9	<0.001
2	PU → SI	0.127	0.133	2.99	<0.001
3	EU → AN	0.844	0.952	13.62	<0.001
4	MHC → PU	0.574	-0.543	1.4	0.151
5	MHC → HA	0.188	0.124	2.24	0.002
6	MHC → MA	-0.364	-0.276	-0.905	0.365
7	MHC → SI	0.527	0.521	7.7	<0.001
8	MHC → PS	-0.234	-0.184	-2.66	0.008

EU: Perceived Ease of use, **SI**: Social Influence, **AN**: New Technology anxiety, **HA**: Habits, **PS**: Perceived Security risk, **CO**: Confirmation, **MA**: Maturity, **PU**: Perceived usefulness, **MHC**: M-health continuance, **SA**: User satisfaction.

Structural equation modeling

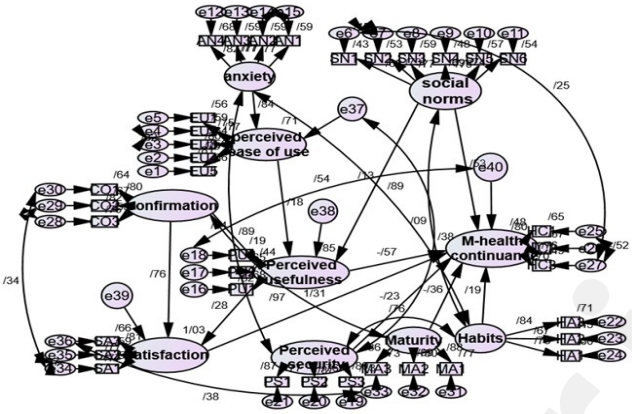
In the present study, the initial fit of the model was checked. The fit of the adjusted model was then assessed and validated (Table 5 and Figure 2).

Table 5. Fit indices for the measurement model and structural model

Fit Indicators	Recommended Value	Measurement Model		Structural Model	
		Before Modification	After Modification	Before Modification	After Modification
χ^2/df	1-3	2.178	1.89	4.771	2.36
CFI	≥0.90	0.925	0.944	0.744	0.910
GFI	≥0.90	2.178	0.854	0.642	0.832

TLI	≥0.90	0.914	0.935	0.724	0.900
IFI	≥0.90	0.926	0.944	0.746	0.911
RMSEA	<0.08	0.061	0.053	0.110	0.066

χ2/df: Chi-square Divided by the Degrees of Freedom, **CFI**: Comparative Fit Index, **GFI**: Goodness-of-Fit Index, **TLI**: Tucker-Lewis Index, **IFI**: Incremental Fit Index, **RMSEA**: Root Mean Square Error of Approximation.



Figer2:Structural Model

Measurement model

The measurement model consists of 33 items distributed across ten variables: perceived security risk, new technology anxiety, social influence, perceived ease of use, confirmation, m-health continuance, maturity, perceived usefulness, habits, and user satisfaction. Six model fit criteria were used to evaluate the overall fit of the model, including the root mean square error of approximation (RMSEA), comparative fit index (CFI), Tucker-Lewis index (TLI), chi-squared divided by degrees of freedom (χ2/df), incremental fit index (IFI), and goodness-of-fit index (GFI). The statistical results of the model fit are summarized in Table 5.

Structural model

The results confirmed six hypotheses, including, 1, 2, 3, 5, 7, and 8. In contrast, hypotheses 4 and 6 did not reach statistical significance and were not supported by this study (Figure 1 and Table 5). Perceived ease of use is influenced by new technology anxiety ($p<0.05$). Furthermore, perceived usefulness is influenced by confirmation, perceived ease of use, and social influence ($p<0.05$). In addition, m-health continuance is influenced by habit ($p<0.002$), social influence ($p<0.05$), and perceived security risk ($p<0.008$).

Discussion

The present study investigated the predictors of Iranian nurses' intention to continue using ECM-based mobile health applications in professional practice. The results showed that the use of m-health services by nurses is optimal, with the majority expressing a willingness to use smartphones for healthcare services. Therefore, m-health technology is an important tool for improving healthcare services. The results of the present study show a positive influence of the model constructs on smartphone use. Further development of these constructs could improve technology acceptance in nursing (34).

The empirical results of the SEM confirm the hypothesized model and show the significant relationships between affirmation and perceived usefulness. Hsiao and Chen (2019) define the perceived usefulness factor as user's understanding of the expected health-related benefits (14). In

addition, the results of the study by Lim et al. (2019) are consistent with the results of the present study (35).

The results of the this study show that nurses recognize the impact of m-health tools on their professional performance. These tools were shown to facilitate data collection, documentation, and analysis of clinical patient data; increase productivity, improve care delivery, promote communication among nursing team members, and support family-centered care.

Social influence factor was the second significant variable associated with the perceived usefulness of m-health tools. Social influence encompasses community preferences and values that can significantly influence user perceptions and attitudes. Importantly, technology acceptance is based not only on individual belief,s but also on social influences such as affiliation and perceived popularity (36).

In the present study, nurses acknowledged the significant influence of upstream organizations, including the Ministry of Health, senior hospital managers, academics, nurses, and physicians, in recognizing the benefits of m-health for the delivery of nursing care. The findings of this study support the assertion of Lwoga and Lwoga (2017) (37).

The study also found a significant relationship between new technology anxiety and the factors of perceived ease of use. Sezgin et al. (2018) also confirmed a significant relationship between new technology anxiety and of perceived ease of use factors (26). Technology anxiety refers to consumers' fears when first encountering a new technology, as well as their willingness and ability to adapt to it. This anxiety can lead to reduced technology acceptance and ultimately hinder users' intention to use the technology (38).

The results of the present study can be attributed to the fact that smartphone anxiety can negatively affect the perceived ease of use factor. Apprehension, fear, and hesitation related to smartphone use can significantly affect perceived ease of use. Given the busy and responsible nature of the nursing profession, it is understandable that there may be some hesitation due to the fear of making mistakes.

The present study did not find a significant relationship between perceived usefulness and m-health continuance. In other words, the role of perceived usefulness in influencing nurses' intention to continue using m-health was interpreted differently than expected in the conceptual model of this study. Despite the importance of perceived usefulness for nurses' intention to continue using m-health, it did not have the expected impact. Previous studies have shown a significant correlation between these factors (39, 40). These different results may be due to different research areas, user characteristics, and system applications.

The results of the present study suggest a significant correlation between habits and m-health continuance factors. Habits refer to the extent to which a person automatically uses m-health applications (14). These findings are consistent with those of a 2019 study by Hsiao and Chen (14). Individual habits are deeply ingrained behaviors that are triggered by situational cues, such as places, people, and past actions (1). These automatic behaviors are associated with smartphone use (2) and the cues that trigger them (40).

The results of the present study indicate that the maturity factor pathway does not significantly influence m-health continuance. This study proposes a maturity model of m-health through the ECM to provide a comprehensive understanding of the factors that influence people's acceptance of m-health and how their use progresses from early to advanced stages. The results of the study by Hsiao and Chen (2019) are inconsistent with those of the present study (14). They suggested that the lack of nurses' approval may be due to the poor quality and dissatisfaction of the technology, leading users to view the system as in need of improvement. Studies have shown that poor graphical user interface design and inadequate process design of smartphone systems lead to preventable medical errors (14). In addition, a lack of understanding of the user interface, user discomfort, and user perceptions of the poor quality of the smartphone system reduce the likelihood of use (14, 42). The development of high-quality user interface designs is critical for mobile learning applications because it can influence user acceptance and usage (43).

The present study revealed a significant relationship between social influence and m-health continuance factors. This finding is consistent with the findings of Chen et al. (44). The study suggests that people are more likely to adopt smartphones for professional use when they observe others doing so, suggesting that influential people play an important role in the perception of new technologies.

The results of the present study confirm the significant influence of perceived security risk on nurses' m-health continuance. Perceived security risk refers to the user's belief in the safety of the technology (45). A study by Weichbroth and Lysik (2020) revealed that smartphone users are increasingly vulnerable to malicious activities, especially when malware applications are installed on their devices, such as smartphones and tablets. These devices store and protect sensitive information, which serves as a deterrent to their use (46). These results are consistent with the findings of Natarajan et al. (2017) (47).

The start of the present study coincided with the corona virus 2019 (COVID-19) pandemic and an increase in nurses' workload, which posed challenges for data collection. The study sample refused to continue participating during data collection, or the questionnaire was not completed in full. As a result, the data collection had to be repeated several times.

Conclusion

Nurses make up a large percentage of hospital staff. Hospitals face potential financial and non-financial risks if nurses do not adopt new technologies in their daily work. Since the clinical care of patients depends on the professional skills and experience of the nurses, m-health tools can improve timely access to medical resources for medical staff. As a result, nurses can improve the quality of patient care and streamline their workflow. The results of this study provide valuable insights into the factors that influence nurses' use of smartphones in their professional roles. In addition, the study sheds light on the challenges and opportunities nurses face when using smartphones. Managers of healthcare organizations who want to encourage continued smartphone use must fully understand the reasons behind this behavior. Therefore, a better understanding of nurses' perceptions of smartphone use is needed to develop new implementation strategies. These strategies should reveal users' attitudes toward smartphones and thus help developers and system administrators improve them and promote their sustainable use.

This study is a useful tool for hospital managers who need to assess the likelihood of success of a new technology. It also helps nurses understand the benefits of use. It focuses on perceived usefulness, perceived ease of use, new technology anxiety, perceived security risk, user satisfaction, habits, maturity, social influence, and endorsement. Overall, the results of this study suggest that nurses' intention to continue using smartphones can only be increased if attention is paid to characteristics related to the maturity of the technology and the user's perception of its usefulness.

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Supplementary Files