Int J Nutr Sci 2025;10(2):261-268

International Journal of Nutrition Sciences

Journal Home Page: ijns.sums.ac.ir

ORIGINAL ARTICLE

Factors Affecting Acceptance of Mobile Health Applications Regarding Dietary Adherence

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ARTICLE INFO

Keywords:
Mobile health
mHealth
Diet
Adherence

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Received: December 26, 2024
Revised: March 23, 2025
Accepted: March 30, 2025

ABSTRACT

Background: Mobile health applications (mHealth apps) are useful for diet adherence. Therefore, knowing the factors affecting the acceptance of mHealth apps and adherence to diet is the main issue in increasing the effectiveness of mHealth interventions. This study was conducted to determine the factors affecting the acceptance of mHealth programs for dietary compliance.

Methods: This cross-sectional study investigated the applicability of Davis's Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) in the acceptance of mHealth apps for dietary adherence among 299 users of dietary mHealth apps. The data collection tool was a standard questionnaire that was distributed in a simple random sampling method.

Results: It was shown that all hypotheses were significant at the 99% confidence level. According to the standard path coefficient (β), all changes in dependent variables were in the same direction as those in the independent variable and had a positive effect. According to the extracted average variance, in terms of predictability, the variable of ease of use was predicted at a medium level and trust was predicted at a weak level. However, the three variables of attitude, intention to use and actual use were strongly predicted.

Conclusion: This study as one of the first studies on the effect of mobile apps adoption on dietary adherence demonstrated its specific theoretical and practical implications.

Please cite this article as: ShojaeiBaghini M, Asadi F, Dehbashi M. Factors Affecting Acceptance of Mobile Health Applications Regarding Dietary Adherence. Int J Nutr Sci. 2025;10(2):261-268. doi: 10.30476/ijns.2025.104464.1358.

Introduction

An optimal diet is characterized by balance, diversity, and nutritional adequacy and is tailored to meet individual nutritional needs to support the health maintenance; while considering personal differences, habits, and preferences too (1). As healthcare providers advise, adherence to a diet encompasses how individuals can closely follow health recommendations, medication schedules, therapeutic plans, and lifestyle modifications (2). Dietary adherence represents a multifaceted behavioral process influenced by demographic factors, intrinsic motivation, dietary beliefs, reminders, and peer support (3). Failure to adhere to a healthy diet can detrimentally impact quality of life, and precipitate a range of conditions from malnutrition to chronic

diseases (4, 5). Challenges such as receiving incomplete or contradictory information can hinder dietary adherence, particularly among those with limited health literacy (6).

In this digital era, smartphone mobile health (mHealth) applications (apps) have emerged as innovative platforms for delivering scalable interventions to a broad audience (7). These apps can provide dietary guidance and facilitate behavioral change, enhance access to healthcare and support the health self-management, education, and assistance in clinical decision-making (8, 9). The ubiquity of smartphones, easy access to apps stores, and minimal technological literacy requirements enable mobile applications to offer convenient, high-quality, and cost-effective health services (10-13).

The mHealth apps encompass a variety of medical services, including dietary support (7, 14). Diet apps, a subset of mHealth, typically offer features such as goal setting for weight, meal planning, recipe suggestions, physical activity tracking, caloric and water intake, and weight monitoring (14, 15). Several researches have demonstrated the effectiveness of mHealth interventions in promoting healthy eating habits and dietary compliance (5, 16-19). For instance, mHealth has improved cancer patients' dietary adherence and physical activity (20). Moreover, some researchers have highlighted the potential of smartphone-based diet plans, such as low-carbohydrate ketogenic diets in facilitating weight loss that underscores the importance of adherence to dietary plans (7).

Investigations in mHealth apps, such as the Jawbone UP™ for Australian truck drivers and multicomponent weight loss interventions, have revealed positive outcomes in terms of physical activity and dietary habits, including reduced energy and sodium intake and increased consumption of fruits (21). Surveys among sport nutritionists have revealed the growing use of smartphone diet apps to assess and track athletes' diets that highlight the utility of such apps in sport nutrition practices (15, 22). However, the success of these programs hinges on user acceptance and adherence (18). Factors such as reliability, ease of use, quality, usefulness, aesthetics, trust, and peer recommendations influence user preferences for mobile apps compliance (18-21).

Research by Akdur *et al.* on the Diyetkolik apps underscores the significance of perceived ease of use, usefulness, price value, and trust in influencing users' behavioral intentions toward adopting and consistently using diet apps. Notably, many users express reservations about purchasing online nutritionist services, highlighting the need for continual reassurance regarding platform security and trust in nutritionists (14). The measurement of user acceptance and adherence to mobile applications is performed by various tools. Despite the availability of devices to measure the potential mHealth adoption, existing models such as the Technology Acceptance Model (TAM) and the Unified Theory of Technology Acceptance and Use (UTAUT) may only partially capture the complexity of healthcare system evaluation. These models often require adaptation or combination with other frameworks in healthcare researches (23-26). Given the pervasive use of diet apps and their potential for promoting dietary compliance, this study aimed to explore the factors that influenced user acceptance of mHealth dietary applications. To increase the value of the study, a combination of two models, TAM and UTAUT was used. By understanding user perspectives, health managers and apps developers can design and implement diet software that can align with the preferences and needs of end users.

Materials and Methods

This study operated within a positivist paradigm, employing a theoretical framework to guide its survey research methodology. This study adopted a quantitative approach as an applied research by conducting a cross-sectional study during 2022. The research population comprised individuals utilizing mobile applications related to diet and nutrition. Eligibility for participation was predicated upon a minimum of three months use of diet or nutrition apps and consent to participate in the study. The minimum sample size was calculated using G-Power 3.1 software, which required 314 participants. This calculation was based on a significance level (α) of 0.01, a statistical power of 0.95, an effect size of 0.15, and five predictor variables (27). Anticipating potential nonresponses and attrition, an additional 10% of the questionnaires were distributed. A simple random sampling method was employed for participant selection. Field investigators visited hospitals and clinics to disseminate questionnaires to eligible participants; among those who (a) were users of any dietary mHealth apps and (b) agreed to participate in the study. The study achieved a high response rate of 90%, which can be attributed to the face-to-face survey methodology.

The data collection instrument was a standardized questionnaire that was divided into two sections. The first section collected demographic information from the participants, including gender, age, level of education, place of employment, and experience. The second section comprised 26 questions aimed to assess variables such as perceived ease (28); ease of use (29); trust (30); security, and attitude (31); intention to use (32); and actual use (33).

All variables were formative. Responses were recorded on a 5-point Likert scale ranging from "strongly agree" to "strongly disagree".

This research followed ethical protocols, while each participant presented verbal informed consent before participating. The study was conducted voluntarily, with a comprehensive explanation of its purpose and methods that were provided to all participants. Strict measures were taken to preserve the confidentiality of all participant information. The Research Ethics Committee of Kerman University of Medical Sciences in Kerman, Iran, endorsed the study, and granted the ethical approval as IR.KMU.REC.1403.067. The study aimed to predict the evaluated five variables of perceived ease of use, trust, attitude, intention to use, and actual use as endogenous variables. Following Chin and Hensler's criteria, these parameters were assessed using the R^2 index, with benchmarks set at 0.19, 0.33, and 0.67 (34). R^2 represents the strength of the relationship between the predicted and observed values (35).

The data underwent initial screening and preprocessing to address indifferent and outlier responses, missing values, distribution shape, internal correlation, and sample size adequacy. Subsequent analysis was conducted using SPSS software (Version 24.0, Chicago, IL, USA) to generate descriptive statistics for the samples. Given the causal hypotheses and their formulation within a structural equation modeling (SEM) framework, MPLUS 8.3.2 software was utilized to test these hypotheses and explore the causal relationships among variables.

Results

Following the screening process, of the 310 questionnaires collected, 294 were considered suitable for analysis. The demographic breakdown revealed a predominance of female participants (76.9%). The age group that was mostly represented was between 30 and 40 years (37.4%), while the majority holding a bachelor degree (34.0%) and most users were overweight (76.9%). Additionally, most respondents (60.5%) reported using dietary software for less than one year, and a significant portion (79.3%) utilized free software (Table 1). According to Figure 1, initial confirmatory factor analysis indicated that the preliminary research model did not meet the construct validity and reliability criteria. Consequently, based on recommendations from the IN6 index software, the intention to use the software variable must be removed. Subsequent re-valuations confirmed that all variable factor loadings were significant and surpassed the threshold of 0.5, thereby established the construct validity.

In terms of reliability, all variables achieved Cronbach's alpha coefficients above the accepted standard of 0.7, supporting the generalizability of the results. Furthermore, the average variance extracted (AVE) for each variable exceeded the 0.5 benchmark, and the composite reliability (CR) values were higher than the AVE values for their respective variables. This achievement of four conditions for convergent validity signified a consistent internal structure for each research variable. In addition, the results of the Fornell and Larcker test showed that the AVE root of all variables was greater than the correlation

Table 1: The characteristics of the study population.

Variable	Category	Frequency	Percentage
Gender	Female	226	76.9
	Male	68	33.1
Age (Year)	<20	15	5.1
	20-30	65	22.1
	30-40	100	34.0
	40-50	69	23.5
	>50	45	15.3
Educational level	Diploma and less	40	13.6
	Associate degree	60	20.4
	Bachelor degree	102	34.1
	Master degree and PhD	92	31.9
Software	Free	233	79.3
	Paid	61	20.7
Duration	<1	178	60.5
	1-3	83	28.4
	>3	33	11.1
Weight	Normal	68	33.1
	Overweight	226	76.9

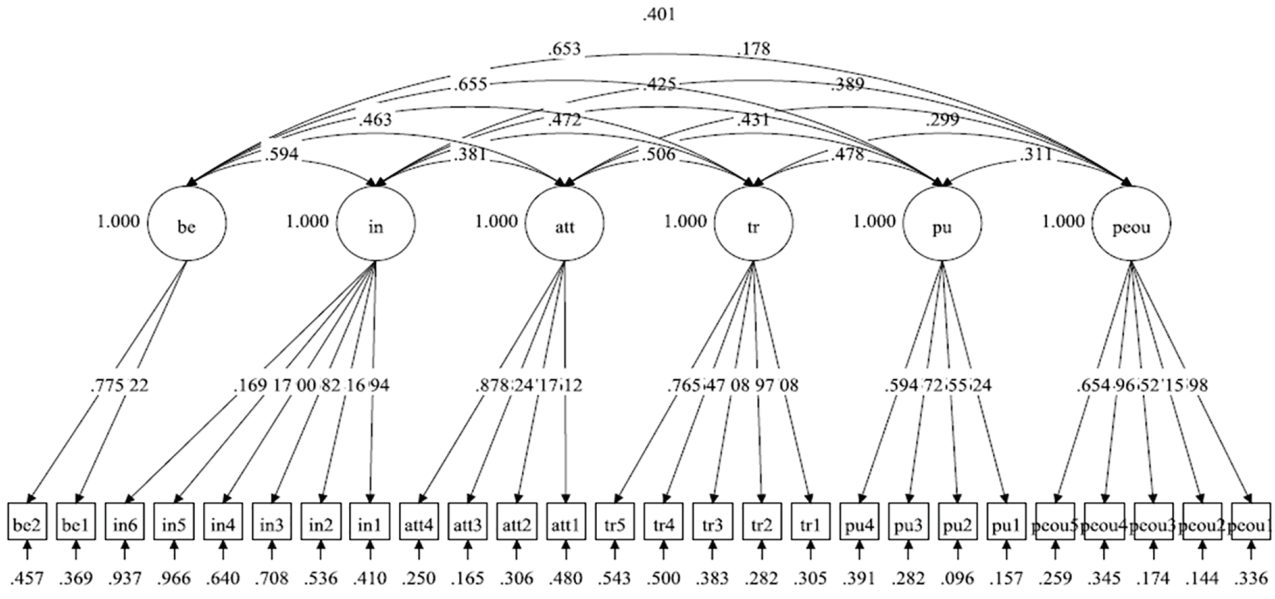

Figure 1: Primary measurement model in the standard coefficient estimation model.

Table 2: Convergent and divergent reliability and validity indices.

				Fornell and Larcker test					
Index	**Cronbach's Alpha**	**AVE**	**CR**	**Perceived Usefulness**	**Actual use**	**Intention to use**	**Attitude toward using**	**Trust**	**Ease of Use**
Perceived usefulness	0.88	0.609	0.885	0.780					
Ease of use	0.86	0.635	0.873	0.311*	0.797				
Trust	0.88	0.593	0.879	0.299*	0.478*	0.770			
Attitude toward using	0.87	0.656	0.883	0.389*	0.431*	0.506*	0.810		
Intention to use	0.78	0.532	0.803	0.178*	0.425*	0.472*	0.381*	0.657	
Actual use	0.72	0.577	0.731	0.401*	0.653*	0.655*	0.463*	0.594*	0.759

*p<0.05, AVE: Average Variance Extracted, CR: Composite Reliability.

Table 3: Fit indices of the modified measurement model.

Metric	Estimate	Threshold	Interpretation
X2	437.459	n/a	n/a
DF	255	n/a	n/a
CFI	0.956	>0.900	pass
RMSEA	0.049 (0.041, 0.057)	<0.100	pass
SRMR	0.049	<0.080	pass

χ2: Chi-Square, df: Degrees of freedom, CFI: Comparative fit index, SRMR: Standardized root mean residual, RMSEA: Root mean square error of approximation.

of that variable with other variables. Therefore, the divergent validity of all variables was also confirmed (Table 2).

According to Table 3, the revised measurement model displayed an excellent fit, as evidenced by the theoretical and statistical literature, suggesting that the observations within the sample were representative of the target population. Considering that the measurement model confirmed the reliability, validity, and compliance of the observations with reality to test the assumptions and the causal relationships between the underlying variables and to predict the behavior of the endogenous variables, the structural model was examined (Figure 2). The structural model analysis confirmed the significance of all research hypotheses at the 99% confidence level, indicating positive correlations between the independent and dependent variables. The standard path coefficients (β) confirmed that changes in the dependent variables were in the expected direction and had a positive impact. In Table 4, the intensity of the effect of each endogenous variable was specified.

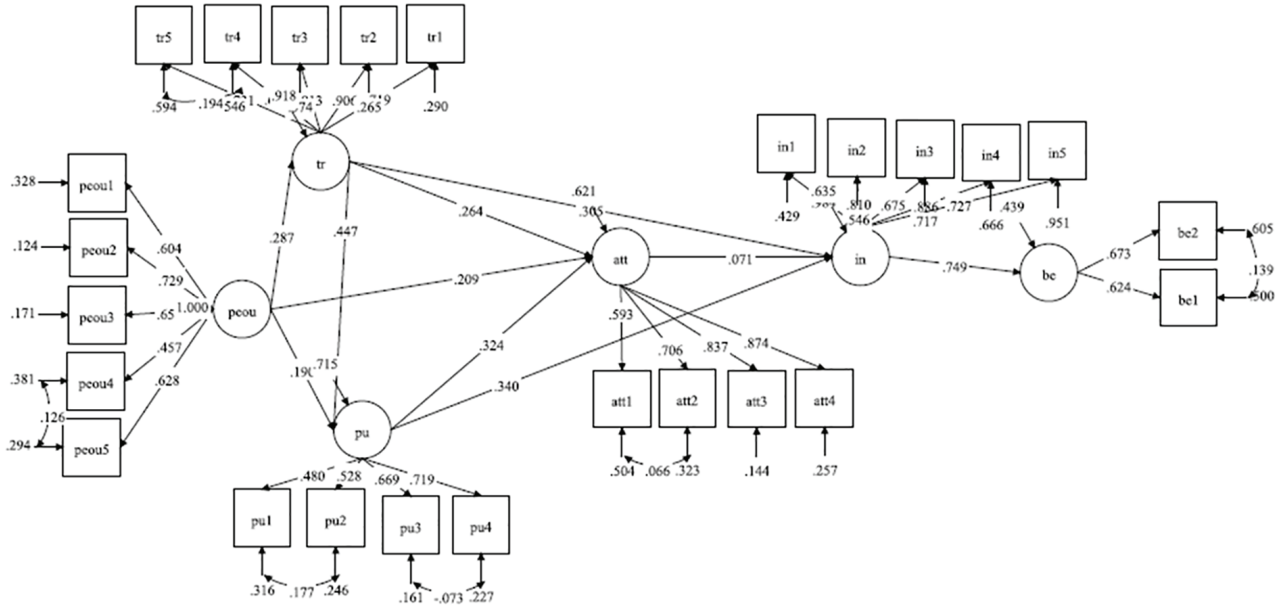

Figure 2: Structural model in standard estimation mode.

Table 4: Hypothesis test for the current variables of the intention to share knowledge.

Hypothesis	Path	β	*P* value	SE	EST/SE
H1	Perceived usefulness ->Ease of use	0.184	0.000	0.061	3.490
H2	Perceived usefulness ->Trust	0.420	0.000	0.060	5.068
H3	Trust ->Ease of use	0.298	0.000	0.058	7.822
H4	Ease of use ->Attitude toward using	0.192	0.003	0.065	2.948
H5	Perceived usefulness ->Attitude toward using	0.226	0.000	0.058	3.904
H6	Trust ->Attitude toward using	0.347	0.000	0.058	5.477
H7	Ease of use ->Intention to use	0.243	0.000	0.073	4.713
H8	Attitude toward using ->Intention to use	0.133	0.096	0.071	1.665
H9	Trust ->Intention to use	0.326	0.000	0.071	4.091
H10	Intention to use ->Actual use	0.643	0.000	0.052	12.279

Table 5: Explained variance.

Endogenous variable	R Square	Interpretation
Ease of use	0.256	Medium
Trust	0.089	Weak
Attitude toward using	0.346	Strong
Intention to use	0.330	Strong
Actual use	0.414	Strong

The findings revealed that perceived ease significantly predicted ease of use at a moderate level. The prediction of perceived ease of trust was considered weak. However, a combination of ease of use, perceived ease, and trust strongly predicted the attitude. Similarly, ease of use, attitude, and trust robustly forecasted the intention to use. Finally, the intention to use strongly predicted actual use, indicating the model's effective formulation (Table 5).

Discussion

This study explored the factors influencing the adoption of mobile apps in relation to diet adherence, by analyzing data from 294 participants and using the structural equation modeling. The necessity of identifying the drivers who encourage users to adopt diet-related mobile apps has been highlighted before showing the pivotal role of diet adherence in an effective weight management (36). The research findings revealed that perceived ease, usability, trust, attitude, and intention were critical in promoting diet adherence through mobile apps. Our results agree with the literature indicating that mHealth interventions can significantly enhance diet adherence, with effectiveness rates up to 70% (15, 37, 38).

The trust in technology is one of the most important motivations to apply mHealth (26, 39). Perceived usefulness, perceived ease of use, trust, and price value were demonstrated to influence the intention of using the Diyetkolik diet plan (13). Chopra *et al.* showed that users' demographic factors, ease of use, and perceived usefulness influenced user acceptance of the program (40). It was shown that psychological factors such as performance expectations, hope for effort, social influence, facilitating conditions, and personal innovation can affect the acceptance of smartphone diet programs by restaurant customers (18). According to Cho *et al.*'s study, personal and social factors can impact the use of diet programs including age, annual income, educational level, perceived obesity, previous diet plans, number of apps currently used, daily time spent on apps, perceived benefits of exercise, and the influence (39).

Our study provided a valuable contribution to the field of mHealth apps and their role in enhancing dietary adherence. The use of TAM and the UTAUT offers a comprehensive framework to understand factors influencing the acceptance of mHealth apps. We used MPLUS for statistical analysis, which is suitable for modeling latent variables, both continuous and categorical, which underlies its flexibility. Based on the researchers' preliminary review, this research is one of the studies investigating the factors influencing the adoption of mobile software for diet adherence, but it also has limitations. First, it was conducted cross-sectionally in a specific geographic population (Kerman city, southern Iran) and may need to be more generalizable to other communities. So future studies can be extended to various populations to enhance representativeness.

A second limitation is that we used a self-report survey for this study. Although self-report surveys are popular and widely used for technology adoption research, this data collection method can have various biases. Thus, future studies can use objective methodologies. A third limitation of this research is its focus on mHealth apps, and the results may not be applied to understanding the behavioral intention to use other healthcare technologies and their related services (such as electronic health records and text messaging). Future studies can be undertaken to investigate other health technologies. Additionally, future studies can consider the trust variable as a potential moderator between intent and actual use to enrich our comprehension of mHealth intervention dynamics.

Conclusion

This study demonstrated the impact of mHealth intervention to promote the diet adherence. As mHealth interventions continue to surge, they offer an accessible and cost-effective mean to diminish health disparities, particularly in developing nations. Integrating mobile phone interventions into healthcare systems has emerged a viable strategy for bolstering adherence and improving dietary outcomes. Nonetheless, the acceptance and effectiveness of such interventions hinge on multiple factors, including perceived ease, usability, trust, attitude, intention to use, and actual use. Our findings can contribute to both theoretical understanding and practical applications in digital and mobile media, pinpointing key motivators behind diet app usage.

Acknowledgement

The authors would like to thank the participants who contributed their time to this project.

Funding

This work was carried out using the authors' own funds.

Authors' Contribution

MSh: Conceptualization and study design, methodology, evaluation and curation, writing-original draft preparation; FA: Data collection, and study design; MD: Data collection, and methodology. All authors read and approved the final manuscript.

Conflict of Interest

The authors declare that they have no competing interests.

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