Evaluation of effective factors in the acceptance of mobile health technology using the unified theory of acceptance and use of technology (UTAUT), case study: Blood transfusion complications in thalassemia patients

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Abstract
Background: Mobile health or MHealth refers to the use of mobile phone in healthcare services to enhance the health level of people. Before using MHealth, it is necessary to study the effective factors in physicians’ adoption and acceptance of technology in the field of thalassemia.

Methods: This cross sectional study was conducted using the survey and correlation methods. The statistical population of the study consisted of hematologists who were selected using the convenience sampling method. In this study, 58 questionnaires along with structural equations modeling based on partial least squares were used. SPSS and SMART PLS2 were used for data analysis. P values less than 0.05 were considered as statistically significant.

Results: Based on the outcomes of the model from all theories, the coefficient of variation seems to be positive and the possibility of test is lower than 5%. The results indicated that all factors introduced in the proposed model are significantly effective in MHealth technology adoption.

Conclusion: In this study, using the inputs from hematologists in hospitals and clinics in Tehran, it was aimed to find the factors affecting the hematologists’ decision to use mobile health technology in reducing the complications of blood transfusion in patients with thalassemia who needed blood transfusion. Thus, plans were made to determine priorities and the existing conditions to implement this new system. Also, the strengths and weaknesses of each factor were measured to improve the weaker factors. UTAUT was used to determine the acceptance factors. After reviewing the results, the use of this model is recommended to physicians.

Keywords: Mobile Health, Unified Theory of Acceptance and Use of Technology (UTAUT), Thalassemia Patients

Introduction
Mobile health or MHealth means providing everyone with healthcare services anytime and anywhere by elimi-
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nating the constraints of time and place, while both the cov-
erage and the quality of the health care indices increase (1, 2). In fact, rapid advancements in IT technology, particu-
larly wireless and mobile communications, has led to the advent of a new information infrastructure that potentially
supports the arrangement of services in advanced MHealth for healthcare (3, 4). The beauty of technology relies on the
fact that it is not limited to a specific country or region. This
technology has broadly extended in the world. Nowadays,
mobile phone technology significantly influences healthcare outcomes and implications in developing coun-
tries (5). In the absence of legal and regulated views, many
physicians do not recommend using apps. However, it was
estimated that 1.5 billion mobile phone users would have
used these apps worldwide by 2018 (6).

In 2018, Bawack and Kamdjoug examined the adequacy of
the unified theory of acceptance and use of technology
(UTAUT) in developing countries. They found physicians
did not tend to accept this theory (7). In the same year,
Venugopal et al (8) using the unified theory of acceptance and use of technology (UTAUT), observed that expected
effort and social influence could have a significant effect
on behavioral intention and facilitating conditions. In an-
other study (9), the authors put forward the initial frame-
work of health technology in developing countries via the
unified theory of acceptance and use of technology
(UTAUT). Moreover, they demonstrated that the given theory
could not suffice to predict the acceptance of informa-
tion technology (IT) in the framework of health systems
strengthening (HSS). Furthermore, Shareef et al (10) inves-
tigated the impact of short message services (SMS) via
smartphones on mobile health. They showed a positive role
of the model developed based on the unified theory of ac-
cceptance and use of technology (UTAUT) in anticipating
consumer perceptions of mobile technology with a focus on
SMS. Hsieh et al (11) found PMT and UTAUT were effec-
tive in predicting the behavior of PHR use. Ease of use was
also considered as a determinant affecting the PHR use. To
examine public acceptance model of mobile health ser-
dviced, Dwivedi et al (12) presented that mobile service sys-
tem was required to reflect cultural characteristics of each
country.

In a review study performed in 2016, Garavand et al (13)
shed light on the acceptance of mobile health technology in a
recent research in which it had been revealed that factors
such as perceived ease of use, perceived usefulness, and fa-
cilitating conditions could increase the percentage of ac-
cceptance of mobile health system. In another research,
Bozan et al (14) evaluated the impact of social influence on
IT acceptance by the elderly by the unified theory of ac-
cceptance and use of UTAUT. The gained consequences
showed that older people were accustomed to sticking to
recommendations by their physicians and were less accept-
ing of technologies. Brown et al (15) used a mixed research
approach to measure the health IT usability evaluation
model (health-ITUEM) in the mobile health domain. The
results demonstrated the usability of the ITUEM frame-
work in assessing mobile health technology.

Using electronic health records (EHR) can greatly im-
prove the quality of treatment with respect to cost-effec-
tiveness, elimination of paperwork, and easy access to pa-
tients’ information (16). In 1994, Aydin and Ischar came
up with the results that older and more traditional physi-
cians were less inclined to use computers in the treatment
process. In addition to the preceding information, Brown
and Kenney also demonstrated the positive influence of
computer experience and computer skills on the adoption
of computer systems for the treatment of patients (17).

The convenience of learning is a factor for doctors to
adopt and work with the new system, because if learning
and working with this system is difficult for physicians who
are the main users of the system, they would prefer to use
paper files (18). MHealth technology can also be used to
help patients with thalassemia to reduce the side-effects
of blood transfusion (19). A challenge in the path of develop-
ment of mobile health technology is how to incorporate it
in physicians and nurses’ practice. Considering that any
new technology is initially facing resistance from some us-
ers, identifying and implementing the effective factors in
adopting this technology for users is essential. A large num-
er of models and theories are available for adopting mod-
ern technologies. Important factors in accepting any tech-
nology can be listed as below:

• Establishing an appropriate strategy for implementation
  consistent with organizational goals;
• Measuring the quality of active processes;
• Allowing intervention of users at all phases;
• Investing in IT (20).

In this study, using compatibility of applying technolo-
gies and their related factors, including expected efficacy,
expected effort, social impact, and facilitating conditions,
we aimed to find effective factors in adoption and ac-
cceptance of using mobile health technology among hema-
tologists using the unified theory of acceptance and
UTAUT.

Methods

This was cross sectional study. To build the model the
following sources were used to collect information: (1)
books, articles, and documents; (2) resources in the domain
of electronic health: written interviews, interviews with ex-
erts and students, and medical records; (3) internet search
for articles in Science Direct, IEEE, Elsevier, etc. The reli-
bility of the questionnaire calculated using Cronbach’s al-
pha was 0.876, which indicates its high reliability and its
content validity was confirmed by experts.

In 2002, Chau and Hu (21) introduced a framework for
the adoption of telemedicine technology. This framework
was designed according to UTAUT and focuses on social
and technical issues. In this study, we present a conceptual
framework that is adapted from Chu et al model (22) (Fig.
1).

The literature conducted from 1997 to 2018 was re-
viewed by searching library references and Google Scholar,
PubMed, Science Direct, and ProQuest databases. The
search was performed using the following key words: ap-
lications, preventive care, and m-health. The identified ar-
ticles were examined based on the objective of the present
study. Out of 450 relevant articles, 19 were identified based on their titles. Eventually, 13 articles were selected for the survey based on inclusion and exclusion criteria (Fig. 2).

After designing the theoretical model (adoption and acceptance of mobile health technology among hematologists based on the UTAUT model provided by Chau and Hu and...
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approved by the experts panel), the questioners were distributed among 58 hematologists community of experts who had been selected by convenience sampling method. After collecting the data, structural equations modeling based on partial least squares was used for data analysis.

**Data Analysis**

In this study, the Cronbach’s alpha (>0.7) and composite reliability (>0.7) were used for questioner reliability. In addition, average variance extracted (AVE) >0.5 and confirmatory factor analysis were used to approve the validity of the questioner.

The numbers obtained from the AVE square root of each construct should be greater than the correlation of that construct with other constructs, which means that each number above the column is supposed to be greater than its lower and upper numbers. The acceptable validity of the model can be gained by comparing the obtained values from the AVE square root of the model constructs with the correlation coefficient of each construct with other constructs.

In this study, the model designed in the qualitative phase was estimated and analyzed using variance base structural equation method and partial least squares analysis method. In this model the value of t presents the significance of variables’ effect. The value of t greater than 1.96 indicates a significant positive effect, between 1.96 and -1.96 a non-significant, and smaller than -1.96 a significant negative effect. Moreover, the path coefficients above 0.6 indicates a strong correlation between the 2 variables, between 0.3 and 0.6 a moderate correlation, and less than 0.3 a weak association.

The SMART PLS2 and SPSS version 18 were used for data analysis.

In this study Pearson correlation was used to examine the correlation among latent variables. Also, p value less than 0.05 was considered as statistically significant.

**Results**

This study was conducted on 32 men and 26 women. The acceptable factor loading is 0.7 for each factor with a significance level of 0.1. Thus, factors with a factor loading less than 0.7 were excluded from the model. The results from testing items consistency showed that all items had a factor loading greater than 0.7. Therefore, the internal consistency of the items was confirmed.

The results indicate that all model constructs have acceptable combinatory validity. This presents the satisfaction of the second condition of the reliability of the model. Moreover, in this study the Cronbach’s reliability coefficient of all variables was at least 0.6. Table 1 shows the

<table>
<thead>
<tr>
<th>Items</th>
<th>Average variance extracted for the items (AVE)</th>
<th>Composite reliability of each structure</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use behavior</td>
<td>0.721324</td>
<td>0.928185</td>
<td>0.909288</td>
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<tr>
<td>Behavioral intention</td>
<td>0.662744</td>
<td>0.850810</td>
<td>0.736081</td>
</tr>
<tr>
<td>Effort expectancy</td>
<td>0.600673</td>
<td>0.811899</td>
<td>0.660448</td>
</tr>
<tr>
<td>Facilitating conditions</td>
<td>0.772529</td>
<td>0.944213</td>
<td>0.925413</td>
</tr>
<tr>
<td>Knowledge of information technology</td>
<td>0.681384</td>
<td>0.893417</td>
<td>0.838204</td>
</tr>
<tr>
<td>Performance expectancy</td>
<td>0.570702</td>
<td>0.870641</td>
<td>0.561506</td>
</tr>
<tr>
<td>Reliability</td>
<td>0.651671</td>
<td>0.788927</td>
<td>0.469612</td>
</tr>
<tr>
<td>Social influence</td>
<td>0.694529</td>
<td>0.809239</td>
<td>0.890646</td>
</tr>
<tr>
<td>Usability</td>
<td>0.772100</td>
<td>0.944062</td>
<td>0.925413</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Items</th>
<th>Performance Expectancy</th>
<th>Effort Expectancy</th>
<th>Social Influence</th>
<th>Facilitating conditions</th>
<th>Knowledge of Information Technology</th>
<th>Usability</th>
<th>Reliability</th>
<th>Use Behavior</th>
<th>Behavioral Intention</th>
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<tbody>
<tr>
<td>Q1</td>
<td>0.899</td>
<td>0.340</td>
<td>0.661</td>
<td>0.744</td>
<td>0.738</td>
<td>0.776</td>
<td>0.666</td>
<td>0.777</td>
<td>0.591</td>
</tr>
<tr>
<td>Q2</td>
<td>0.948</td>
<td>0.179</td>
<td>0.584</td>
<td>0.771</td>
<td>0.683</td>
<td>0.681</td>
<td>0.571</td>
<td>0.682</td>
<td>0.496</td>
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<tr>
<td>Q3</td>
<td>0.900</td>
<td>0.115</td>
<td>0.427</td>
<td>0.642</td>
<td>0.537</td>
<td>0.520</td>
<td>0.410</td>
<td>0.621</td>
<td>0.335</td>
</tr>
<tr>
<td>Q4</td>
<td>0.841</td>
<td>0.079</td>
<td>0.392</td>
<td>0.590</td>
<td>0.459</td>
<td>0.445</td>
<td>0.335</td>
<td>0.646</td>
<td>0.260</td>
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<tr>
<td>Q5</td>
<td>0.110</td>
<td>0.828</td>
<td>0.318</td>
<td>0.259</td>
<td>0.162</td>
<td>0.245</td>
<td>0.135</td>
<td>0.354</td>
<td>0.060</td>
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<td>Q6</td>
<td>0.221</td>
<td>0.736</td>
<td>0.367</td>
<td>0.324</td>
<td>0.143</td>
<td>0.237</td>
<td>0.127</td>
<td>0.562</td>
<td>0.052</td>
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<td>Q7</td>
<td>0.147</td>
<td>0.767</td>
<td>0.225</td>
<td>0.228</td>
<td>0.142</td>
<td>0.210</td>
<td>0.100</td>
<td>0.589</td>
<td>0.025</td>
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<td>Q8</td>
<td>0.533</td>
<td>0.327</td>
<td>0.904</td>
<td>0.731</td>
<td>0.539</td>
<td>0.619</td>
<td>0.509</td>
<td>0.320</td>
<td>0.434</td>
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<tr>
<td>Q9</td>
<td>0.429</td>
<td>0.269</td>
<td>0.881</td>
<td>0.609</td>
<td>0.402</td>
<td>0.473</td>
<td>0.363</td>
<td>0.674</td>
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<tr>
<td>Q10</td>
<td>0.548</td>
<td>0.318</td>
<td>0.756</td>
<td>0.605</td>
<td>0.579</td>
<td>0.517</td>
<td>0.407</td>
<td>0.618</td>
<td>0.332</td>
</tr>
<tr>
<td>Q11</td>
<td>0.512</td>
<td>0.251</td>
<td>0.873</td>
<td>0.697</td>
<td>0.471</td>
<td>0.483</td>
<td>0.373</td>
<td>0.714</td>
<td>0.298</td>
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<tr>
<td>Q12</td>
<td>0.706</td>
<td>0.270</td>
<td>0.913</td>
<td>0.738</td>
<td>0.694</td>
<td>0.809</td>
<td>0.699</td>
<td>0.510</td>
<td>0.624</td>
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<tr>
<td>Q13</td>
<td>0.627</td>
<td>0.235</td>
<td>0.788</td>
<td>0.828</td>
<td>0.589</td>
<td>0.625</td>
<td>0.515</td>
<td>0.326</td>
<td>0.440</td>
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<tr>
<td>Q14</td>
<td>0.713</td>
<td>0.282</td>
<td>0.612</td>
<td>0.910</td>
<td>0.753</td>
<td>0.791</td>
<td>0.781</td>
<td>0.592</td>
<td>0.706</td>
</tr>
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<td>Q15</td>
<td>0.655</td>
<td>0.343</td>
<td>0.673</td>
<td>0.932</td>
<td>0.660</td>
<td>0.803</td>
<td>0.693</td>
<td>0.504</td>
<td>0.618</td>
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<tr>
<td>Q16</td>
<td>0.778</td>
<td>0.272</td>
<td>0.581</td>
<td>0.886</td>
<td>0.730</td>
<td>0.768</td>
<td>0.658</td>
<td>0.469</td>
<td>0.583</td>
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<td>Q17</td>
<td>0.831</td>
<td>0.247</td>
<td>0.540</td>
<td>0.868</td>
<td>0.750</td>
<td>0.749</td>
<td>0.639</td>
<td>0.450</td>
<td>0.564</td>
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<td>Q18</td>
<td>0.721</td>
<td>0.227</td>
<td>0.623</td>
<td>0.803</td>
<td>0.941</td>
<td>0.832</td>
<td>0.722</td>
<td>0.533</td>
<td>0.647</td>
</tr>
<tr>
<td>Q19</td>
<td>0.553</td>
<td>0.090</td>
<td>0.478</td>
<td>0.639</td>
<td>0.918</td>
<td>0.715</td>
<td>0.605</td>
<td>0.416</td>
<td>0.530</td>
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<tr>
<td>Q20</td>
<td>0.688</td>
<td>0.239</td>
<td>0.638</td>
<td>0.851</td>
<td>0.977</td>
<td>0.842</td>
<td>0.732</td>
<td>0.543</td>
<td>0.657</td>
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<tr>
<td>Q21</td>
<td>0.675</td>
<td>0.271</td>
<td>0.61</td>
<td>0.837</td>
<td>0.984</td>
<td>0.807</td>
<td>0.697</td>
<td>0.508</td>
<td>0.622</td>
</tr>
<tr>
<td>Q22</td>
<td>0.686</td>
<td>0.267</td>
<td>0.623</td>
<td>0.857</td>
<td>0.808</td>
<td>0.98</td>
<td>0.87</td>
<td>0.681</td>
<td>0.795</td>
</tr>
</tbody>
</table>
results of the test of the combined validity of each construct. Acceptable values for this criterion suggesting the validity of the measuring instruments is 0.5. These values are indicated in Table 1, i.e., AVE. The results of AVE for each construct indicate that the third condition of the model’s reliability has been satisfied and the value of the extracted variance for each construct is more than an acceptable value of 0.5.

Examination of cross loading of items
Table 2 presents the results of the cross loading of each item on its construct and other constructs. The factor loading of each item on its construct must be at least 0.1 more than the factor loading of the same item on other constructs (Table 3).

Examining the correlation among latent variables
Table 3 shows the correlation matrix among the latent variables from the PLS algorithm test, where the diameter of the matrix has been replaced with the AVE square root.
related to each construct.

Figure 3 and Table 4 demonstrate the value of coefficients between the 2 variables. The variables were extracted from the conceptual framework introduced in the method section (Fig. 1).

Also, because of the positive CV-com index in Figure 4 of the quality model, the measurement quality is appropriate.

**Discussion**

In this study we aimed to find effective factors in the acceptance of mobile health technology by hematologists with the help of UTAUT theory. According to the model of the research and theoretical literature using the structural equations modelling based on partial least squares, in the first step the reliability, combinatory validity, external validity, and average variance extracted were examined. In this regard, the obtained results showed that the factor loading of each item on other constructs should be at least 0.1 lower than the factor loading of that item on its construct. This means that factor loading of any item and correlation between latent variables were acceptable, indicating the model possessed appropriate validity. Furthermore, the extracted values variance was greater than 0.5 for each item.
which is satisfactory. Moreover, the evaluation of the main aim of the research was conducted through the analysis of hypotheses. In this study, the analysis of the hypotheses revealed the variables that were identified in the review of texts as influential variables in the acceptance of mobile health technology were also confirmed in a small phase. Thus, factors and increased reliability and accessibility of this technology in hematologists will lead to a reduction in the side effects of blood transfusions in patients with thalassemia.

This study has investigated more factors compared with previous studies. For example, Venugopal et al (8) examined “expected efforts”, “social influence,” “behavioral intention,” and “facilitating conditions”. Another study (13) examined the 3 factors of “perceived ease of use”, “perceived usefulness”, and “facilitating conditions”. “Computer experience” was investigated in one research (17) and “convenience of learning” was examined in another study (18). The studied population also varied in different studies. For example, Bozan et al (14) examined old patients in their study and found older people are not willing to accept technology. In the present study, all factors introduced in the study of Chau and Hu (21) were examined for technology acceptance, and hematologists were the study population. The results showed that all investigated factors affect the acceptance of technology by hematologists (21).

Conclusion

Based on the findings of this study, using mobile health technology has not matured yet and many concepts of this technology need more scientific attention, especially in Iran. Moreover, the acceptance of mobile health technology among hematologists and the effective factors in this regard have not been examined prior to this study. According to the results of this study and in order to design applied studies and extract new information in the field of accepting mobile health technology, some of the following suggestions can be mentioned:

1. Investing the acceptance factors of mobile health technology among other medical groups.
2. Evaluating the ability of mobile health technology to ensure the success of the process of medical care.
3. Studying the challenges of using mobile health technology with which people would be faced and the probable solution.

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Conflict of Interests

The authors declare that they have no competing interests.

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http://mjiri.iums.ac.ir

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