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# The effect of using mobile health on self-management of type 2 diabetic patients: A systematic review in Iran

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**Abstract:**

Type 2 diabetes, as one of the most common chronic diseases, requires ongoing management and support from the patient; therefore, patient participation and self-management play a pivotal role in controlling and preventing this disease. The increasing use of smartphones has provided a good opportunity for controlling and managing patients with type 2 diabetes. This study aimed to investigate the effect of mobile health on the self-management of patients with type 2 diabetes in Iran. A systematic review study was conducted from 2010 to 2021. Searches in Persian and English scientific databases, IranDoc, MagIran, SID Web of science, and PubMed, were performed using keywords such as diabetes and mobile health. The process of reviewing and selecting articles based on inclusion and exclusion criteria was performed by two researchers independently. The study evaluation was performed by using a standard tool. After selecting articles, data extraction was performed using a data extraction form. Data analysis was performed with a content analysis approach. Finally, 23 articles were included from the 7767 articles found in the initial search stage, which examined patients' self-care in 11 areas using mobile health. Fourteen studies (61%) considered mobile health to be effective in increasing hemoglobin control. Other studies also found the use of mobile health in increasing adherence to exercise (n = 10), increasing adherence to medication (n = 9), increasing adherence to diet (n = 11), increasing care for diabetic foot ulcers (n = 8), increasing self-efficacy and empowerment (n = 5), increasing cholesterol control (n = 4), increasing awareness and attitude (n = 4), increasing control of insulin dose (n = 2), increasing adherence to education (n = 1), and increasing control of blood urea (n = 1), which were considered effective. The use of m-health effectively controls the disease and promotes self-management in type 2 diabetic patients. Considering the high cost of diabetes treatment, policymakers should implement appropriate interventions and strategies in the field of using mobile health to improve adherence to self-management of the disease.

**Keywords:**

mHealth, mobile health, self-management, telemedicine, type 2 diabetes

## Introduction

Diabetes mellitus (DM) is the most common chronic disease and metabolic disorder in which patients suffer from high blood sugar. Insulin is a hormone that helps regulate and stabilize blood sugar in the body. In patients with DM, the body cannot produce insulin, so it is not enough, or the cells do not respond to and receive insulin in the blood.[1,2] Each of these reactions has created a specific type of diabetes; generally, there are three main types of diabetes, including type 1 diabetes, type 2 diabetes, and gestational diabetes mellitus (GDM).[3] Diabetes can lead to long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels,[1,4] and to diseases such as stroke and heart disease, which lead to neuropathy, nephropathy, and retinopathy.[5] The International Diabetes Federation (IDF) estimates that approximately 6.7 million



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people will die from diabetes and its complications in 2021, equating to one death every five seconds.[6] Despite efforts to increase patients' life expectancy, diabetes is still the fifth leading cause of death in Asia and the third leading cause of death in Iran.[1,7] The IDF also estimates that by 2021, approximately 537 million adults aged 20–79 will be living with diabetes. According to IDF forecasts, the number of people with diabetes will reach 643 million adults by 2030, and this number will increase to 783 million by 2045.[6] The damage that diabetes does to health budgets worldwide is significant.[5] The global cost of diabetes in 2021 is estimated at $ 966 million. The cost is reported to be about $ 1838.4 per person with diabetes.[6]

Among the diabetes types, DM is the most common type, with 90–95% of incidence.[8] Studies have shown that one of DM's main treatments and prevention methods is establishing a healthy lifestyle.[8] As a result, improving eating habits and physical activity can increase life expectancy in patients with DM and effectively reduce the complications of this disease.[9-11] DM requires ongoing patient management and support.[12] However, the patient's time with his doctor during a year is only about 10 hours.[13] Given that the prevention and management of DM depend mainly on individual behaviors, expanding patient support beyond the clinic may contribute to self-management.[14] Therefore, education and support for diabetes self-management are important elements in the care of patients with diabetes.[15] Today, self-management has become a common term in health education.[16]

Diabetes self-management is a set of defined activities and behaviors that the patient performs to control and manage diabetes in their daily lives.[17] Self-management in diabetes includes measuring and recording blood glucose, having physical activity and exercise, following a diabetic diet, and taking the medication regularly.[18] The use of technology in education, support, and management of self-care in diabetes has expanded since the advent of mobile technology with comprehensive access and acceptance by many people.[12] Widespread acceptance of mobile phones and smartphones is an opportunity to improve self-care and self-management in patients with diabetes.[19] Mobile apps have also made it possible to record, transmit, and receive feedback anytime and anywhere, making it easier to remotely monitor and provide timely health care advice. In general, mobile applications can increase self-management.[15]

The use of smartphones or portable digital devices to support activities, medical operations, and health services is called mobile health. Mobile health interventions (mHealth) have overcome many traditional barriers by providing comfort and care in a natural environment and minimizing distance, time, and cost barriers. MHealth interventions for clinicians provide side effects and identify areas for improvement.[20] Although mHealth may not be a substitute for professional health care, teaching primary prevention information can play a supportive role in prevention and management to make informed decisions about their lifestyles and behaviors.[14] Researchers have used mobile health applications in type 2 diabetes self-management in recent decades. For example, Mao *et al*. concluded that using mHealth effectively affects patients' self-efficacy with diabetes.[21] In a study by Bráulio *et al*.,[22] mobile apps effectively improved HbA1c control in patients with diabetes. They pointed out that using better information and health education to patients through this mobile application can enhance self-care understanding in patients with diabetes. Wu *et al*.[23] also considered the use of interventions based on mobile applications to cause a clinically significant reduction in HbA1c in adult outpatients with diabetes, especially in patients with type 2 diabetes. The study by Wu *et al*.[24] also found ample evidence of the effectiveness of mobile apps for lifestyle modification in DM.

According to Marcolino's study, the popularity of mHealth is growing, but the evidence for its effectiveness is still limited.[25] The results of our investigations have shown that so far, no systematic study has been conducted regarding the effect of using mobile health on the self-management of type 2 diabetic patients in Iran. The studies carried out in this field in Iran have investigated the use of mobile phones in the management of diabetic patients[26] and the examination of patients' attitudes regarding the use of mobile health.[27] Therefore, to fully understand the effect of mHealth on self-management in type 2 diabetes in Iran, there is a need for a systematic review of recent articles. The present study was conducted to determine the effect of using mHealth in the self-management of type 2 diabetic patients in Iran.

## Materials and Methods

To achieve the study aim, we conducted a systematic review to identify the accompanying mHealth effects on type 2 diabetes self-management in 2021.

### Study design

This systematic review study was conducted based on the proposed steps of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[28]

### Search strategy and data sources

We searched SID, MagIran, and IranDoc databases to retrieve published sources in the Persian language. PubMed and Scopus databases were searched to retrieve

published articles in the English language between 2010 and 2021 related to Iran. The search of sources in the mentioned scientific databases was performed based on the combination of keywords shown in Table 1.

### Inclusion and exclusion criteria

The inclusion criteria in this study were research articles of the clinical trial type that examined the effect of co-morbid health on the self-management of DM. All short articles, letters to the editor, review articles, and articles whose full versions were not available for any reason were excluded from the study process. The study process was excluded.

### Quality evaluation of the articles

The quality evaluation of the articles included in the study was also evaluated using the Delphi List tool.[29] This tool has criteria for measuring the quality of clinical trial studies, which has nine main sections and examines items such as treatment allocation, the benefit of appropriate inclusion criteria, blinded assessment of outcomes, and blindness of patients admitted to the study.

### Data extraction

After selecting studies with inclusion criteria, data were collected using a data extraction form that is based on the objectives of the study; these data include bibliographic information of the article, place of study, demographic information of the target population, the purpose of the study, duration of intervention, and self-management items (adherence to exercise and physical activity, adherence to medication, adherence to diet, adherence to education, control of hemoglobin, control of blood urea level, control of insulin dose, control of cholesterol, foot care, level of knowledge and attitude, self-efficacy, and empowerment). Data were extracted by two members of the research team independently, and after comparison, the existing discrepancies were resolved.

**Table 1: Search strategy in scientific databases**

| Time limitation | 24 October 2021 |
|---|---|
| Language limitation | English and Persian |
| Database | MagIran, SID, IranDoc, PubMed, Scopus |
| #1 | "Health Technology" OR "Mobile App" OR "Digital Health" OR "Mobile Application" OR "Smart Phone" OR "Mobile Health Technology" OR "Message Application" OR "SMS" OR "Short Message Service" OR "Short Message" OR "Electronic Health" OR "M-Health" OR "E-Health" OR "Mhealth" OR "Ehealth" OR "Text Messaging" OR "Cellphone" OR "Telemedicine" OR "Mobile Health" OR "Apps" |
| #2 | "Insulin Resistant" OR "Insulin" OR "Blood Sugar" OR "Blood Glucose" OR "Hyper Glycaemia" OR "Diabetes Complication" OR "Diabetes Incipidus" OR "Diabetes Mellitus" OR Diabetes |
| #3 | IRAN |
| Search | #1 AND #2 AND #3 |

### Data analysis

We conducted the data analysis through the content analysis method. The results of the analyses are also summarized and reported based on the study objectives in tables and figures.

The researchers respected honesty and trust in reporting the results of related studies.

## Results

Seven thousand seven hundred sixty-seven articles were retrieved and entered into resource management software (Endnote). After removing duplicates, articles were screened based on title evaluation, abstract, and full-text review based on inclusion and exclusion criteria; finally, 23 articles were included in the study. The search strategy of these articles is shown in Figure 1.

All studies were interventional and included intervention and control groups. Based on Table 2, most of the studies were performed in Tehran (n = 7), Karaj (n = 2), Hamedan (n = 2), Ahvaz (n = 2), and Urmia (n = 2). A descriptive view of these articles is provided in Table 2.

According to Figure 2, in 65.22% of studies (n = 15), the duration of intervention was 3 months (12 weeks).

Another part of the study showed that the methods used to implement diabetes self-management programs included text message service, telephone calls, educational software, educational packages, web pages, and mobile games.

Among these methods, the most intervention was dedicated to text message service (n = 8) and telephone call (n = 6). However, in four studies, text messages and telephone calls were used simultaneously to implement patients' self-management programs [Figure 3].

The study results showed that mobile health applications in DM self-management have such vast areas. These applications include adherence to exercise programs, medication adherence, diet, adherence to education, hemoglobin control, blood urea control (BUN), insulin dose control, cholesterol control, foot care, level of awareness and attitude, and self-efficacy and empowerment. According to the study results, the use of mobile health in controlling hemoglobin (n = 15) was the most important goal of using mobile health in the management of patients with diabetes. Other details about the applications of accompanying health in the self-management of patients with type 2 diabetes are shown in Figure 4.

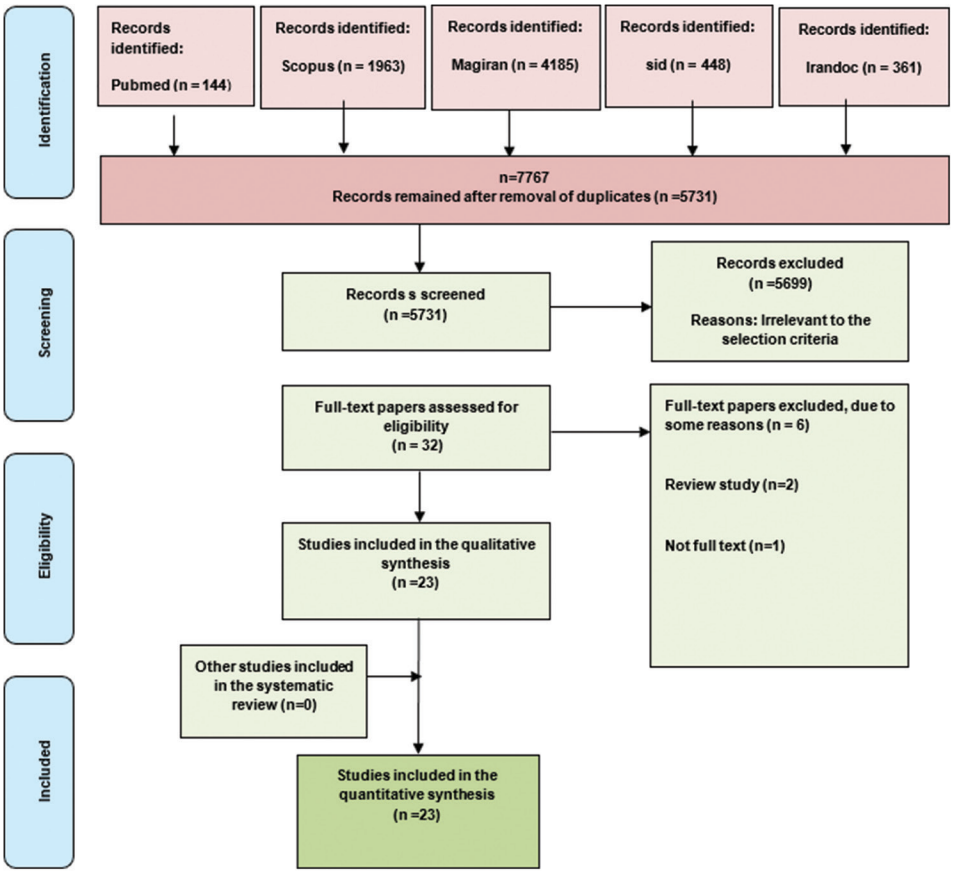


**Figure 1:** Flow diagram of the included and excluded studies

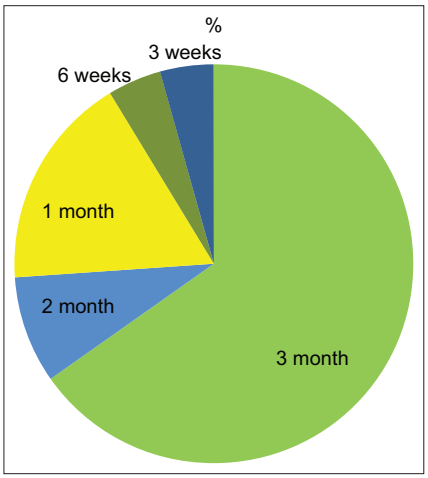


**Figure 2:** Duration of intervention

## Discussion

The use of mobile health capabilities to manage and control diabetes, especially type 2 diabetes, has increased increasingly around the world and also in Iran, and studies in this regard are conducted every year. It seems that because of the rapid growth of mobile technology in Iran and the situation of penetration and acceptance of mobile health among Iranian users, the pattern of using technology for self-management of diabetes is different from other countries and communities.[51,52] The most common method of using mobile health in self-management of patients with diabetes in Iran based on the results of this study has been the use of text messages. Also, a wide range of applications for self-management of this group of patients using mobile health tools and capabilities have been reported, including helping to control hemoglobin.

Diabetes has a worrying prevalence worldwide based on the World Health Organization (WHO) predicting that by 2030, approximately 366 million people will have diabetes.[53] In addition, although both types of diabetes are increasing, the prevalence of DM is more rapid because of lifestyle changes (such as sedentary and overweight). Although diabetes can not be cured, it can be controlled with the right interventions. In people with diabetes, educating patients is as important as medication, exercise, and diet because treatment will never be effective unless one knows the nature of the disease and takes the proper steps to do so.[54]

Mobile health has created a new revolution in providing various health services in the present age and has become

**Table 2: The features of included studies**

| Author, Year | Study aim | Location | Participants | Age (mean and SD) |
|---|---|---|---|---|
| Borhani *et al*.,[30] 2013 | The effect of mobile application on glycosylated hemoglobin in patients with DM | Tehran | Intervention *n*=30<br>control group *n*=30 | Intervention group 42.86±7.17<br>control group 44.36±11.62 |
| Tizabi *et al*.,[1] 2019 | Determining the effect of education through mobile SMS on knowledge and attitude toward self-management of DM patients | Chabahar | Intervention group *n*=37<br>control group *n*=37 | Intervention group 8.5±43<br>control group 7.4±43.5 |
| Goodarzi and Ebrahimzadeh,[2] 2014 | The effect of mobile phone-based education on metabolic control in diabetic patients | Karaj | Intervention group *n*=43<br>control group *n*=38 | Intervention group 50.98±10.327<br>control group 56.71±9,776 |
| Baghiani Moghadam *et al*.,[31] 2014 | The effect of educational text messages designed based on the health belief model on the adoption of self-care behaviors of patients with DM | Birjand | Intervention group *n*=45<br>control group *n*=43 | Intervention group 7.49±48.89<br>control group 8.51±50.60 |
| Mohammadi *et al*.,[32] 2017 | Evaluation of the effect of telephone nursing follow-up on self-efficacy of women with type 2 diabetes | Hamedan | Intervention group *n*=55<br>Control group *n*=54 | 72.78±13.07<br>73.22±11.87 |
| Peimani *et al*.,[33] 2016 | Evaluation of the effectiveness of SMS-based education in supporting diabetic patients | Tehran | Targeted SMS group *n*=50<br>Non-targeted SMS group *n*=50<br>control group *n*=50 | Targeted SMS group: 49.78±9.76<br>Non-targeted SMS group: 53.26±10.49<br>control group: 54.56±9.88 |
| Rahnavard *et al*.,[34] 2019 | Comparison of the effect of group and mobile-based training on self-care behaviors in DM patients | Ahvaz | Mobile-based training group *n*=30<br>Group training group *n*=30<br>Routine training group *n*=30 | Mobile-based training: 46.7±7.5<br>Group training: 49.2±5.7<br>Routine training: 48.8±7.8 |
| Baji *et al*.,[35] 2016 | Determining and comparing the effect of profit-oriented and loss-oriented messages via mobile phone SMS on foot care behavior in women with type 2 diabetes referred to Ahvaz Diabetes Clinic | Ahvaz | Profit-based SMS group *n*=63<br>Loss-based SMS group *n*=63<br>Control group *n*=63 | Profit-based SMS group: 47.16±10.23<br>Loss-based SMS group: 48.43±9.17<br>control group: 49.0±9.49 |
| Zolfaghari,[36] 0 | Comparison of the effect of two follow-up methods (telephone and mobile) on diet adherence in the areas of diet, exercise, and medication in patients with type 2 diabetes | Tehran | Telephone follow-up group *n*=39<br>Mobile follow-up group *n*=38 | - |
| Lari *et al*.,[37] 2018 | The effect of SMS service based on health promotion model (HPM) on physical activity of diabetic patients | Boshehr | Intervention group *n*=37<br>control group *n*=36 | Intervention group 46.10±9.14<br>control group 49.13±9.07 |
| Maslakpak *et al*.,[38] 2017 | Evaluation and comparison of the effectiveness of family-based education provided by face-to-face and telephone methods on self-care behavior and patient outcomes in Iranian patients with DM | Urmia | Group 1: Family-centered face-to-face training: *n*=30<br>Group 2: Telephone-based family-based education *n*=30<br>Group 3: control group *n*=30 | Group 1 Family-centered face-to-face training: 49.9±4.98<br>Group 2 Telephone-based family-based education±49.46 4.76<br>Group 3: Control group 50.6±3.74 |

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**Table 2: Contd...**

| Author, Year | Study aim | Location | Participants | Age (mean and SD) |
|---|---|---|---|---|
| Naghibi *et al*.,[39] 2015 | Evaluation of the use of SMS in self-care of diabetic patients | Sari | Intervention group *n*=77<br>Control group *n*=76 | 44.26±11.2<br>44.26±11.2 |
| Yarahmadi *et al*.,[40] 2014 | Determining the effect of face-to-face information therapy on glycosylated hemoglobin (HbA1C) control in type 2 diabetic patients in Isfahan | Isfahan | Intervention group *n*=32<br>control group *n*=32 | 53±7.3<br>52.6±8.2 |
| Zolfaghari *et al*.,[41] 2012 | Evaluation and comparison of the effectiveness of nurse SMS services via SMS and telephone follow-up by the nurse on the level of glycosylated hemoglobin HbA1c in people with type 2 diabetes. | Tehran | Telephone follow-up group *n*=39<br>SMS group *n*=38 | Telephone group: 53.71±9.04<br>SMS group: 51.70±9.90 |
| Zamanzadeh *et al*.,[42] 2016 | Evaluating the effect of telephone and SMS services on empowerment of patients with type 2 diabetes | Urmia | Intervention group *n*=33<br>control group *n*=33 | 48.45±4.98<br>48.97±5.63 |
| Nesari *et al*.,[43] 2010 | Determining whether a nurse telephone follow-up service can improve adherence to a diabetes treatment regimen in patients with type 2 diabetes. | Tehran | Intervention group *n*=30<br>control group *n*=31 | 51.9±7.6<br>51±8.2 |
| Zolfaghari *et al*.,[44] 2012 | Comparison of the effectiveness of two methods of SMS follow-up and telephone follow-up on adherence to type 2 diabetes for 3 months. | Tehran | Short message group 38=*n*<br>Telephone group 39=*n* | SMS group 51.07<br>Telephone group 50.71 |
| Sarayani *et al*.,[45] 2018 | Evaluating the effect of a pharmacist's telephone intervention to improve drug adherence, self-care activity, and HbA1c in short- and medium-term follow-up (3 and 9 months) in patients with DM | Tehran | Intervention group *n*=50<br>control group *n*=50 | 53.4±10.3<br>56.7±11.5 |
| Goodarzi *et al*.,[46] 2012 | The effect of text message use on improving laboratory test levels and knowledge, attitude, practice, and self-efficacy of patients with DM in Iran. | Karaj | Intervention group *n*=43<br>control group *n*=38 | 50.98±10.32<br>56.71±9.77 |
| Jafari *et al*.,[47] 2013 | The effect of nutrition education using blogs, group participatory blogs, and SMS on blood sugar and lipids in type 2 diabetic patients | Kermanshah | Blog Group *n*=20<br>Collaborative blog group *n*=20<br>SMS group *n*=20 | blog: 50.9±8.2<br>Collaborative blog: 52.6±8.9<br>SMS: 51.0±9.0 |
| Amini *et al*.,[48] 2020 | Determining the effect of using mobile home care program on treatment adherence of patients with type 2 diabetes | Hamedan | Intervention group *n*=40<br>Control group *n*=40 | Intervention group 54.73±7.80<br>control group 58.7±95.84 |
| Koohmareh *et al*.,[49] 2021 | The effect of playing Amoo mobile game on increasing the diet information of patients with type 2 diabetes | South west of Iran | Intervention group *n*=30<br>control group *n*=30 | Intervention group 43.93±8.99<br>control group 44.13±7.91 |
| Shahsavari and Foroghi,[50] 2015 | The effect of nurse telephone follow-up on adherence to treatment plan in DM patients | Aligodarz | Intervention group *n*=30<br>control group *n*=30 | Intervention group 60.83±11.62<br>control group 60.10±11.49 |

| Author, Year | Type of Intervention | Time of Intervention | Conclusion and Suggestion |
|---|---|---|---|
| Borhani *et al*.,[30] 2013 | Using installed software on smartphones | 3 months | The use of telemedicine (mobile software) can reduce glycosylated hemoglobin in patients with type 2 diabetes.<br>Because of the contradiction in the results of the research, it is suggested to conduct more studies. |

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**Table 2: Contd...**

| Author, Year | Type of Intervention | Time of Intervention | Conclusion and Suggestion |
|---|---|---|---|
| Tizabi *et al*.,[1] 2019 | Send educational SMS | 4 weeks | The educational intervention has been effective in promoting patients' knowledge and attitude.<br>It is suggested that the results of this study be tested in larger communities to encourage managers to provide more effective and less expensive education to patients and change lifestyles to prevent diseases. |
| Goodarzi and Ebrahimzadeh,[2] 2014 | Educate patients through short message service | 12 weeks | Educational intervention using mobile capabilities has a positive effect.<br>It is suggested to increase the sample size in the next studies and to propose a system for the whole country, to repeat the study on a wider level, and conduct longitudinal and interventional studies. |
| Baghiani Moghadam *et al*.,[31] 2014 | educational text messages | 1 month | Educational text messages are useful for adopting self-care behaviors among diabetics. |
| Mohammadi *et al*.,[32] 2017 | Phone call | 12 weeks | Nurse telephone follow-up has been effective in promoting self-efficacy in women with diabetes.<br>It is suggested that the use of telephone nursing and landline telephone lines for education, consultation, follow-up, and answering possible questions of patients with chronic diseases such as diabetes should be considered in health and treatment centers. |
| Peimani *et al*.,[33] 2016 | Two intervention groups:<br>Targeted individual SMS and non-targeted SMS<br>Targeted SMS group:<br>75% of the messages were set and sent based on the two main barriers to self-care adherence mentioned by each patient in the questionnaire.<br>In the non-targeted SMS group:<br>Messages were randomly selected and sent to each patient. | 3 months | Sending text messages as a medium for education and conventional diabetes treatment is effective in glycemic control and other aspects of self-care. Also, sending regular general educational text messages at a specific time is just as effective as sending individual and targeted educational text messages. |
| Rahnavard *et al*.,[34] 2019 | Two intervention groups:<br>Group training group and<br>Mobile-based training group<br>In group training group:<br>Eight 90-minute face-to-face training sessions<br>In mobile-based education: Installing educational software on patients' phones | 2 months | Follow-up and group-based training and mobile (educational software) increased the average score of self-care compared to routine training. The effect of group-based and mobile-based training was not significantly different in all areas of self-care except foot care.<br>It is recommended to use the mobile-based education method for elderly patients and patients who cannot go to medical centers. |
| Baji *et al*.,[35] 2016 | Send an educational SMS<br>(one group of profit-oriented messages and the other group of loss-oriented messages) | 2 months | The mean scores of foot care behavior increased in the intervention groups, and harmful messages were more effective in motivating patients to perform foot care behaviors than benefit-oriented messages.<br>It is recommended to implement the study in the wider dimensions of a more diverse target community. |
| Zolfaghari,[36] 0 | Telephone follow-up group: Telephone call for 20 minutes during the intervention period (twice a week in the first month and once a week during the second and third months).<br>Mobile follow-up group:<br>Send about six messages a week. | 3 months | Both telephone follow-up and mobile follow-up interventions reduced glycosylated hemoglobin levels and improved adherence to the treatment regimen. |
| Lari *et al*.,[37] 2018 | Receive educational SMS | 3 months | Educational messages were effective in changing the beliefs and physical activity behaviors of diabetic patients.<br>It is recommended to use mobile phones and SMS as accessible and affordable tools to change the health beliefs of diabetic patients and induce health-promoting behaviors such as physical activity. |

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**Table 2: Contd...**

| Author, Year | Type of Intervention | Time of Intervention | Conclusion and Suggestion |
|---|---|---|---|
| Maslakpak *et al*.,[38] 2017 | Group 1:<br>In-person training<br>Group 2:<br>Call | 3 months | The effect of educating patients and their family members on self-care and diet, physical activity, glucose monitoring, and foot care in intervention groups is more beneficial than the control group.<br>Comparison of two intervention methods showed that in-person training is more effective than telephone training in diet and physical activity. Telephone intervention has comparable and even better results than face-to-face training in glucose monitoring.<br>Future studies are needed to confirm the efficacy and feasibility of such family-oriented educational interventions on the outcomes of other diabetes patient populations. |
| Naghibi *et al*.,[39] 2015 | Send messages | 4 weeks | The use of SMS effectively strengthens the self-care of diabetic patients so that the performances of diabetic patients in foot care, exercise, drug use, and their attitudes before and after the intervention were significantly different.<br>Although using virtual trainings, especially SMS is not so wide spread in health care educational programs, regarding the growing increase of communication and digital gadgets and people easily accessing them, to utilize virtual educational methods is recommended as an appropriate approach for various health and self-care and follow-up training programs for diverse groups in society, particularly chronic and diabetic patients. |
| Yarahmadi *et al*.,[40] 2014 | Training package and SMS | 3 months | Pursuing education for type 2 diabetic patients through training packages and SMS had positive effects on patients' HbA1C control.<br>Considering the low cost and high effectiveness of this method, it is recommended that health care providers include it in their work. |
| Zolfaghari *et al*.,[41] 2012 | Mobile follow-up group:<br>Send SMS<br>Telephone group:<br>Voice call | 3 months | Intervention using SMS via mobile phone and telephone follow-up by a nurse improved HbA1c for 3 months in type 2 diabetic patients. It can be considered as an alternative method to control diabetes. |
| Zamanzadeh *et al*.,[42] 2016 | Educational SMS and phone calls | 3 months | Providing education by phone and SMS has an effective role in promoting self-empowerment of type 2 diabetic patients.<br>It is suggested to conduct similar studies for other chronic diseases such as heart, lung, and kidney diseases and in different cultures. |
| Nesari *et al*.,[43] 2010 | call | 3 months | Telephone follow-up by the nurse was effective in increasing the level of adherence to the diabetes treatment regimen so that the level of HbA1c decreased.<br>It is recommended to design studies to compare different telenursing approaches in improving adherence to treatment regimens in chronic diseases in relation to patient satisfaction and costs. |
| Zolfaghari *et al*.,[44] 2012 | Telephone group via telephone call<br>SMS group by sending message | 3 months | Both telephone follow-up and SMS interventions are effective in increasing dietary adherence, physical activity, and drug adherence as well as in controlling HbA1c in Iranian adults with type 2 diabetes.<br>Considering the ease of SMS, it is suggested to be used as an alternative method to follow up diabetic patients. |
| Sarayani *et al*.,[45] 2018 | Call | 3 months | Drug adherence and self-care outcomes can be improved by using a telephone-based intervention in short- and medium-term follow-up periods. |

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**Table 2: Contd...**

| Author, Year | Type of Intervention | Time of Intervention | Conclusion and Suggestion |
|---|---|---|---|
| Goodarzi *et al*.,[46] 2012 | Send message | 12 weeks | Cell phone SMS intervention is effective in the management of type 2 diabetes and can improve knowledge, attitude, practice, self-efficacy, and laboratory level testing in patients with type 2 diabetes in a randomized controlled trial.<br>Further studies are recommended for the widespread use of distance education using mobile phones. |
| Jafari *et al*.,[47] 2013 | In the blog group:<br>Nutritional information was provided multimedia to use type 2 diabetic patients on the web.<br>In the group participatory blog group:<br>A group of people collected nutritional information about type 2 diabetes, shared their successful experiences and new information, and then shared it on the web for public use.<br>In the SMS group:<br>Twice a week, nutritional content was sent via SMS. | 3 weeks | E-nutrition training (blogs, group blogs, and text messages) has positive effects on blood lipid levels, and these changes can reduce the effects of diabetes in people with diabetes.<br>The use of blogs and text messages in the education of patients with type 2 diabetes is recommended. |
| Amini *et al*.,[48] 2020 | Education based on educational content.<br>Both theoretically and practically face-to-face and practical demonstration for the patient with the presence of at least one family member and with the help of educational equipment such as educational booklet, poster, educational video, and educational replica during two sessions of home visits in each session for 40 minutes and two telephone follow-ups were done once a week. | 1 month | Implementing a home care program can increase the follow-up of the treatment of diabetic patients who have been referred to the Diabetes Research Center and who do not have appropriate follow-up treatment.<br>Since the data of the study were collected by self-report and there was a possibility of providing unrealistic answers, it is suggested that future studies be conducted by direct observation and interview. |
| Koohmareh *et al*.,[49] 2021 | The intervention group played "Amo" for 15 minutes daily, and the control group did not participate in the game. | 6 weeks | Amoo mobile game can increase the knowledge of patients with type 2 diabetes about food calories and glycemic index. This means that mobile games may serve as an educational aid for these patients.<br>In this study, glycemic index was selected because it is a fundamental tool, but it is suggested that glycemic index and glycemic load be incorporated in future versions of the game. |
| Shahsavari and Foroghi,[50] 2015 | telephone follow-up | 12 weeks | Nurse telephone follow-up is an effective way to improve glycemia and adhere to the treatment plan in patients with type 2 diabetes.<br>It is suggested to conduct similar studies on patients with chronic diseases with a larger sample size and a population-based sampling method to investigate the impact of follow-up and the use of modern communication technologies in educating patients and estimating their costs. |

an integral part of people's daily lives.[55] Follow-up through mobile communication reduces unnecessary visits and can refer patients to the best care providers. The results showed that mobile health effectively promotes awareness, knowledge, and adherence to patients' self-management behaviors and increases patient awareness.[56,57] People with DM have played an influential role in self-management and reducing the complications of this disease through various means such as text message service, telephone calls, educational software, educational packages, web pages, and mobile games. The results of a study by Cui *et al*.[18] showed that smartphone-based self-management programs effectively control blood sugar. The present study results also showed that mHealth-based interventions could lower blood sugar in patients with diabetes.

Based on the assessment of included articles, it can be said that existing mHealth interventions can effectively promote lifestyle changes, including daily physical activity and changes in medication needs. Many of the costs of treating DM patients are borne by the government,

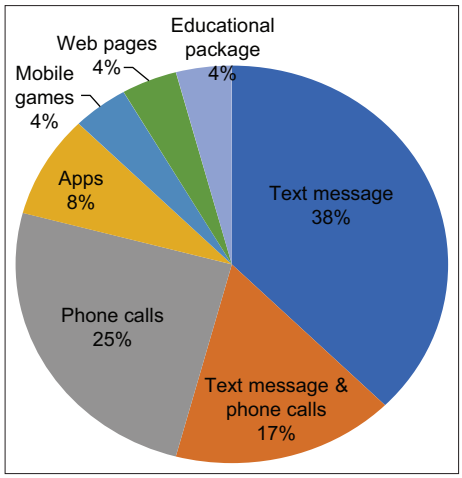


**Figure 3:** Mobile health-based methods for self-management of patients with type 2 diabetes in Iran

and the government is responsible for providing various healthcare services such as providing insulin. It suggested that mobile health-based tools be widely used in public care centers for being used by people with diabetes to make changes in people's lifestyles and to save resources by helping to change patients' lifestyles and reduce the need for specialized services.

In a study by Mokaya *et al*.[58] that examined the effect of mHealth interventions on HbA1c in patients with low-income DM, they used mobile text messages and mobile applications to perform mHealth interventions. The results of this study indicated a decrease in HbA1c in the intervention group, which was consistent with our study. Also, in this study, similar to ours, the text message was used as the most common mHealth approach; given the widespread use of ICT in developing countries, e- and mHealth approaches to promote physical activity and a healthy diet can be implemented.[59] Considering the need for DM diet control and controlling blood sugar levels and accompanying health in helping diabetic patients manage food intake, it is suggested to define a codified mechanism for physicians to recommend these tools to patients. In this way, it can be increased by patients. Another noteworthy point is that the design and development of mobile health tools should be based on needs and correct and accurate.

Drug adherence is also an essential aspect of diabetes self-management, and adherence behavior can be targeted by mHealth interventions. Farmer *et al*.[60] examined the effect of short messages on improving adherence to diabetes drugs. This study provided evidence that the messages positively affect drug adherence and clinical outcomes, which is in line with the results of our study. MHealth programs increase compliance, empower patients, and enable more intensive, more closely monitored treatment.

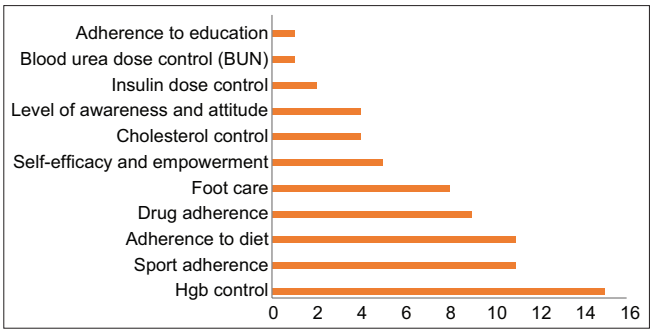


**Figure 4:** Mobile health applications in self-management of type 2 diabetes patients in Iran

The main difference between our study and other studies in this field is the study of all items of self-management, including adherence to exercise and physical activity, medication adherence, adherence to diet, adherence to education, hemoglobin control, blood urea control, control of insulin dose, cholesterol control, foot care, level of awareness and attitude, self-efficacy, and empowerment. Because behavior change or helping to modify the patient's old behaviors is the main goal of patient education and in addition positive behavioral changes lead to increased patient participation in self-management, effective education that can provide sufficient information to the patient and support and careful control can improve patient adherence and thus reduce the chronic complications of diabetes and improve the quality of life of diabetic patients.[46,61-63] Mobile health apps may be helpful for those trying to get into good habits in everyday life. Our study showed that mHealth interventions could effectively educate and change people's attitudes toward self-management.

The results of our investigations have shown that so far, no systematic study has been conducted regarding the effect of using mobile health on the self-management of type 2 diabetic patients in Iran, and on the other hand, considering that the studies conducted in this field in geographical areas and on a limited population, which have been performed from Iranians, the necessity of conducting more studies seems necessary.

## Conclusion

By expanding the use of smartphones among people in the community, its capabilities can be used to help the process of caring for chronic patients. This technology has a wide range of capabilities to provide services to patients with diabetes, including educating patients and reminders to adhere to their treatment processes, such as adherence to diet, medication, and exercise.

Studies in Iran have shown that mHealth has an influential role in controlling the disease and promoting self-management in type 2 diabetic patients. Many of

the interventions and services required for patients with type 2 diabetes can be performed remotely. It is suggested that mobile health capabilities be used to provide services to the community with diabetes more widely. Because of the increasing number of people with diabetes in the community and the constant need for education, counseling, and follow-up, mHealth can be used to provide health services in dealing with chronic diseases, especially diabetes.

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## Conflicts of interest

There are no conflicts of interest.

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