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ORIGINAL ARTICLE

Evaluation of SMS-intervention in patients with diabetes on disease perception and treatment compliance

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Abstract

Background: Nowadays, as in all health branches, health communication technologies are used in diabetes to develop positive health behaviors and the self-efficacy of patients. The aim of this study was to evaluate the effect of SMS-intervention on disease perception, health behavior, and improvement initiatives for treatment compliance in diabetic patients.

Methods: This intervention type study was conducted at Afyon Kocatepe University, Ahmet Necdet Sezer Research and Application Hospital in Turkey. Diabetic patients (n=136) were randomly assigned to three groups. These were "Control", "Reminder", "Information and Motivation". The "Reminder" and "Information and Motivation" groups received regular SMS for one year.

Results: In our study, there was a significant increase for health beliefs and treatment compliance in "Reminder" and "Information and Motivation" groups after the intervention. However, there was no significant difference in "Control" group. The SMS sent to diabetes patients positively affected their health belief and treatment compliance. Especially in the "Information and Motivation" group, differences were found in all parameters of the Health Belief Model Scale.

Conclusions: SMS interventions are easy and effective interventions that can be used to improve positive health behaviors and positive health perception in individuals. Such interventions, especially for common diseases such as diabetes, will make a significant contribution to the control and treatment of the disease.

Keywords: Health Communication, Diabetes Mellitus, Treatment Compliance, Cell Phone, Health Behavior.

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INTRODUCTION

Although non-infectious diseases were seen as the problem of developed countries and elderly populations in the past, today, independent of socio-economic situation, people of every country and age group are affected. Non-communicable diseases are the most important cause of death worldwide (1). Diabetes is one of the non-communicable diseases that cause the most deaths throughout the world. There has been a stable increase in the prevalence of diabetes in the last few decades and projections show that this increase will continue. Thus, it is a priority public health issue worldwide (2,3).

Patients with diabetes may develop many acute and chronic complications during the course of the disease. To prevent diabetes complications and to better the course of the disease, it is important to comply with the clinical treatment. Studies show that lifestyle changes such as physical activity, a proper diet, and regular blood sugar control can delay or prevent complications (3–5). Non-compliance with treatment is directly connected to bad treatment outcomes (5,6). Behavior changes in individuals are an important step in the treatment of chronic diseases because of its direct effect on treatment results.

In the past, it was thought that a behavioral change could only be achieved by giving information. Today, it is accepted that information does affect attitude and behavior, but this relationship is a multi-factored pattern rather than a direct effect (7,8). Therefore, various models have been developed to explain the health behaviors of individuals. One of the models that is thought to fit patients with diabetes is the Health Belief Model (8,9). According to the Health Belief Model, the beliefs that the individual is sensitive to the disease, the emergence of the disease will affect his/her life, the severity of the disease will decrease when he/she takes action, and he/she will not encounter negativities such as cost, shame, and pain affects the health behavior of the individual (10).

Although the Health Belief Model is concerned with explaining health habits, it does not declare how to change health behavior. But Albert Bandura's Social Cognitive Theory identifies factors that explain health behaviors and how to inform, lead, and motivate people to ensure this change was understood. According to Bandura, the expectations of the individual about physical health, acceptance of the behavioral change to be developed in the social environment, and setting of goals that are based on the individual are effective in the development of positive health behavior (11). These positive health behaviors are of great importance in the prevention and treatment of diseases such as diabetes, directly related to lifestyle and health rituals.

Nowadays, as in all health branches, health communication technologies are used in diabetes to develop positive health behaviors. With health communication technologies such as Short Messaging Services (SMS), phone calls, voice mail systems, and e-mail; it is possible to carry out broad and promising interventions to develop the self-efficacy of patients with diabetes (12–14). In addition, previous studies show that SMS, mobile applications, or phone calls are effective in terms of blood sugar monitoring, continuing education, diet, exercise, and regulation of treatment and that the interventions contributed to blood sugar control (15,16).

Based on the positive results of these previous interventions, we aimed to evaluate the effect of SMS-intervention on disease perception, health behavior, and improvement initiatives for treatment compliance.

MATERIALS AND METHODS

This intervention type study was carried out from 01.12.2016 to 01.03.2018 at Afyon Kocatepe University Ahmet Necdet Sezer Research and Application Hospital.

Identification of Patients

All 143 patients who visited the Endocrinology Clinic of Afyon Kocatepe University Ahmet Necdet Sezer Research and Application Hospital in Turkey, between 01.12.2016 and 28.02.2017, met the inclusion criteria, and agreed to participate in the study were included in the study without determining the sample. Inclusion criteria were being over the age of 18, having diabetes, using oral antidiabetic medication or insulin, being literate, being able to use a mobile phone, and being able to read SMS. Being under the age of 18 or pregnant were exclusion criteria.

Participants in the study were divided into three groups by method of simple random sampling (groups were determined by drawing lots after the sequence number was given to the patients): The included patients were randomly divided into three groups: "Control" (n=48), "Information and Motivation" (n=48), and "Reminder" (n=47). During the study, one patient died and one patient voluntarily left the study. Four people were excluded because they could not be reached at the end of the study and one person did not have laboratory measurements. A

total of 7 patients, 1 patient from the "Control" Group, 2 patients from the "Information and Motivation" Group, and 4 patients from the "Reminder" Group were excluded from the study and the evaluations took place with 136 patients.

Content of the intervention

The first interview with the patients was carried out after their first visit to the clinic. The patients were interviewed face-to-face in a quiet room where privacy conditions were met. The study plan and the possible advantages and disadvantages of the study were explained in detail to the patients and verbal and written consent was obtained. Data were collected by a face-to-face interview during the first visit to the clinic with the patients and by phone at the end of the study.

No interventions were carried out with the patients in the "Control" group. The "Reminder" and "Information and Motivation" groups received regular SMS for one year, between the first and last interviews, as intervention. The "Reminder" group received a daily message saying, "Don't forget your diabetes medication today. Please apply your treatment as directed by your doctor."

The patients in the "Information and Motivation" group received a weekly phone message for one year. A total of 52 different messages were used. The content of the messages were designed according to the "Social Cognitive/ Learning Theory" by Bandura (11). Messages that create a social support idea (e.g. Tell your family and friends how they can help you, they will support you.), create positive expectations (e.g. Proper blood sugar control will prevent the occurrence of secondary diseases related to diabetes), and determine reachable goals (e.g. Moderate exercise at least 2.5 hours per week will help balance your blood sugar level) were sent.

Data Collection Tools

At the beginning of the study, we used the face-to-face interview method with the patients. To collect the data, we used the First Interview Survey Form, developed by us, and the Health Belief Model in Diabetes Scale, consisting of 33 questions (the scale developed by Schwab et al. was the foundation, which was modified by Tan with 5 dimensions, Cronbach α=0.72) (17). The Turkish validity and reliability study of the Health Belief Model in Diabetes Scale was carried out by Kartal and Özsoy in 2005. The subdimension Cronbach α-values of the Turkish scale varied from 0.73 to 0.89 and the total Cronbach α-value of the scale was 0.86 (18).

The first interview survey form questioned the patients' sociodemographic characteristics, diabetic diagnosis, treatment, course (when was the diagnosis, type of diabetes, treatment received, physical exercise, and compliance with medication treatment (0=worst compliance, 10=full compliance)), and health status (0=I am very unhealthy, 10=I am very healthy).

The fasting blood glucose (FBS), glycosylated hemoglobin (HbA1c), total cholesterol, high density lipoprotein (HDL), low density lipoprotein (LDL), triglyceride, blood urea nitrogen (BUN), and creatinine levels, measured during their hospital visits throughout the year, were obtained from the hospital information system.

To evaluate the effectiveness of the intervention, the patients included in the study were contacted by phone and the Last Interview Survey and the Health Belief Model in Diabetes Scale, which consisted of 33 questions, were filled out. The subjects in the First Interview Survey that were expected to change were questioned again in the Last Interview Survey (diet, physical exercise, medical treatment compliance, and health status). In addition, questions about the phone messages and their content were added.

Ethical Compliance of the Study

This study was approved by the clinical research ethics committee of the Afyon Kocatepe University (Date: 02.12.2016 number: 60).

Statistical Evaluation

The obtained data were evaluated with descriptive statistics (arithmetic mean, median, standard deviation, and percentage distributions). First, the suitability of normal distribution was evaluated using Kolmogorov-Smirnov and Shapiro-Wilk tests when comparing mean values between groups. The means of more than two independent groups were compared using ANOVA in cases where parametric assumptions were met and the Kruskal-Wallis test in cases where it was not met. When parametric assumptions were met, the T-test was used in the comparison of repetitive measurements of dependent groups and the Wilcoxon test if they were not met. Percentage distribution of categorical data between groups was compared with the Chi-Square test. SPSS v18 program was used for data analysis and $p<0.05$ was accepted as significant.

RESULTS

It was determined that of the patients, 90.4% (n=123) had Type 2 diabetes and 9.6% (n=13) Type 1 diabetes. It was observed that 80.9% used oral antidiabetics, 42.6% used insulin, and 5.2% used an insulin pump. The age of the 136 diabetes patients in our study varied from 20-82, the mean age was 51.76±12.50, and 54.4% of the patients were female. While there was a significant difference in mean age between the groups (p=0.008), there was no significant difference regarding the other sociodemographic indicators (sex, place of residence, income status, and educational status) (Table 1).

Table 1. Sociodemographic characteristics of the groups

	Control Group		Reminder Group		Information and Motivation Group		KW	p
	Min-Max	Mean±SD	Min-Max	Mean±SD	Min-Max	Mean±SD		
Age	20-82	54.6±14.8	22-77	50.2±10.2	20-70	50.2±11.2	9.703	0.008
	n	%	**n**	%	**n**	%	**X^2**	**p**
Sex								
Male	21	44.7	18	41.9	23	50.0	0.617	0.734
Female	26	55.3	25	58.1	23	50.0		
Place of Residence								
Village-small town	15	319	7	163	11	239	2.992	0.224
Province-district	32	581	36	837	35	561		
Income Status								
Low	11	234	12	279	7	152	2.157	0.340
Middle-High	36	766	31	711	39	848		
Educational Status								
Primary School graduate	24	510	28	651	27	587	9.377	0.153
Middle School graduate	6	128	4	93	5	109		
High School graduate	6	128	9	209	10	217		
University / College graduate	11	234	2	47	4	87		

There was no significant difference between the groups at the beginning of the study regarding diet, physical exercise, medical treatment compliance, and health status of the patients (p=0.256, p=0.911, p=0.600, and p=0.644, respectively).

According to the subjective evaluation of the patients, the beginning and end scores regarding diet (p=0.763), physical exercise (p=0.458), compliance with medical treatment recommendations (p=0.083), and subjective health status (p=0.405) of the "Control" group did not show any significant differences.

When comparing the compliance with the diet recommendations of the patients, there was a significant increase in the "Reminder" (p=0.001) and "Information and Motivation" (p=0.034) groups after the intervention. The comparison of the compliance with physical exercise and medical treatment recommendations after the intervention only increased in the "Reminder" group (p=0,001, p=0.003, respectively). According to the self-evaluation of the patients, those in the "Information and Motivation" group gave themselves higher scores regarding their health status (p=0.030) (Table 2).

Table 2. Treatment compliance and subjective evaluation of health status of the groups before and after the intervention

	Before Intervention	After Intervention		
	Mean±SD	Mean±SD	t-Z	p
Compliance with diet recommendations				
Control Group	6.05±2.37	5.47±2.00	-0.302**	0.763
Reminder Group	4.69±2.76	5.98±2.06	-3.467*	**0.001**
Information and Motivation Group	6.02±2.34	6.50±2.16	-2.197*	**0.034**
Compliance with physical exercise recommendations				
Control Group	6.39±2.75	5.88±2.67	-0.741**	0.458
Reminder Group	5.69±2.95	6.93±2.56	-3.565*	**0.001**
Information and Motivation Group	6.78±2.66	6.86±2.64	-0.328*	0.747
Compliance with medical treatment				
Control Group	8.46±2.12	8.17±1.51	-1.732**	0.083
Reminder Group	7.22±3.07	8.49±1.79	-3.003**	**0.003**
Information and Motivation Group	8.36±2.47	8.70±2.00	-1.578**	0.115
Subjective health status				
Control Group	7.24±1.81	7.28±1.41	-0.832**	0.405
Reminder Group	7.26±2.10	7.69±1.88	-1.393*	0.172
Information and Motivation Group	7.45±2.24	7.89±1.92	-2.242*	**0.030**

*= Dependent Group T Test was used

** =Wilcoxon Test was used

The examination of the patients' health beliefs showed no significant differences between the groups with respect to perceived susceptibility (p=0.693), perceived severity (p=0.529), perceived benefits (p=0.914), perceived barriers (p=0.804), recommended health-related activities (p=0.075), and Belief Model in Diabetes Scale total score (p=0.703) before the intervention.

The evaluation of the Belief Model Scale of the patients with diabetes before and after the intervention is shown in Table 3. No significant change was determined over time regarding health belief in the "Control" group. The comparison of the Health Belief Model Scale subheadings in the "Control" group before and after the study showed a significant increase in perceived severity (p=0.046) but no significant changes regarding perceived susceptibility (p=0.583), perceived benefits (p=0.070), perceived barriers (p=0.169), and recommended health related activities (p=0.085).

Table 3. The groups' health beliefs before and after intervention

	Before Intervention	After Intervention	t-Z	P
	Mean±SD	Mean±SD		
Perceived susceptibility				
Control Group	3.03±0.46	3.26±0.58	-0.549**	0.583
Reminder Group	3.06±0.50	3.10±0.48	-0.983*	0.331
Information and Motivation Group	2.97±0.49	3.18±0.52	-3.887*	**<0.001**
Perceived severity				
Control Group	3.80±0.63	4.11±0.60	-1.992**	**0.046**
Reminder Group	3.66±0.47	4.15±0.53	-4.067**	**<0.001**
Information and Motivation Group	3.74±0.61	4.25±0.56	-4.661**	**<0.001**
Perceived benefits				
Control Group	4.02±0.54	4.19±0.50	-1.810**	0.070
Reminder Group	4.05±0.44	4.16±0.45	-2.453*	**0.019**
Information and Motivation Group	4.05±0.39	4.44±0.37	-9.508*	**<0.001**
Perceived barriers				
Control Group	3.77±0.42	3.75±0.52	-1.376**	0.169
Reminder Group	3.72±0.32	3.75±0.35	-0.920*	0.363
Information and Motivation Group	3.74±0.40	3.90±0.31	-3.470*	**0.001**
Recommended health related activities				
Control Group	4.22±0.46	4.32±0.45	-1.724**	0.085
Reminder Group	4.13±0.33	4.21±0.34	-3.075*	**0.004**
Information and Motivation Group	4.31±0.35	4.52±0.32	-5.875*	**<0.001**
Total scale score				
Control Group	3.86±0.37	3.99±0.39	-1.494**	0.134
Reminder Group	3.83±0.25	3.93±0.27	-4.375*	**<0.001**
Information and Motivation Group	3.89±0.31	4.15±0.27	-8.395*	**<0.001**

*= Dependent Group T Test was used

** =Wilcoxon Test was used

Health belief ($p<0.001$) significantly increased in the "Reminder" group after the intervention. The comparison of the Health Belief Model Scale subheadings in the "Reminder" group before and after the intervention showed no significant change in perceived sensitivity ($p=0.331$) and perceived barriers ($p=0.363$) but significant increases regarding perceived severity ($p<0.001$), perceived benefits ($p=0.019$), and recommended health related behaviors ($p=0.004$).

Health belief ($p<0.001$) significantly increased in the "Information and Motivation" group after the intervention. The comparison of the Health Belief Model Scale subheadings in the "Information and Motivation" group before and after the intervention showed significant increases in all subheadings, which were perceived susceptibility ($p<0.001$), perceived severity ($p<0.001$), perceived benefits ($p<0.001$), perceived barriers ($p=0.001$), and recommended health related activities ($p<0.001$).

The evaluation of the biochemical parameters of the patients with diabetes showed no significant difference between the groups regarding FBS (p=0.213), total cholesterol (p=0.487), LDL (p=0.848), triglycerides (p=0.115), BUN (p=0.988), and creatinine (p=0.550) values.

In Table 4, the measured biochemical parameters of the patients before and after the intervention were evaluated. A significant increase in HDL (p=0.008) and significant decrease in triglyceride levels (p=0.034) were determined in the "Information and Motivation" group after the intervention, but no significant changes were seen regarding FBS (p=0.722), HbA1c (p=0.739), total cholesterol (p=0.131), LDL (p=0.204), BUN (p=0.722), and creatinine (p=0.722). There was no significant difference between the measured biochemical parameters before and after intervention in the "Control" and "Reminder" groups.

Table 4. Measured biochemical parameters of the groups before and after intervention

	Before Intervention	After Intervention		
	Mean±SD	Mean±SD	t- Z	p
FBS				
Control Group	166.73±77.80	161.31±83.81	-0.105**	0.916
Reminder Group	193.01±84.06	157.47±72.09	0.947*	0.354
Information and Motivation Group	176.51±76.14	162.40±59.11	-0.356**	0.722
HbA1c				
Control Group	7.51±1.84	7.51±1.55	-1.290**	0.197
Reminder Group	8.17±2.05	7.58±1.85	1.406*	0.174
Information and Motivation Group	7.88±1.48	7.48±1.54	0.337*	0.739
T. cholesterol				
Control Group	194.14±37.26	183.53±34.80	-0.148*	0.884
Reminder Group	189.65±48.58	184.94±43.69	1.386*	0.182
Information and Motivation Group	195.13±38.98	180.30±49.17	1.575*	0,131
HDL				
Control Group	50.74±17.17	48.77±13.54	1.806*	0.084
Reminder Group	44.09±13.78	42.98±10.93	1.619*	0.122
Information and Motivation Group	41.60±10.89	44.61±9.04	-2.663**	**0.008**
LDL				
Control Group	127.81±39.00	121.57±35.95	0.001*	0.999
Reminder Group	131.22±40.94	124.06±36.39	1.034*	0.314
Information and Motivation Group	132.89±36.08	128.11±40.47	1.314*	0.204
Triglycerides				
Control Group	152.04±69.04	146.63±67.45	-1.909*	0.069
Reminder Group	165.51±125.58	180.64±125.29	0.972*	0.343
Information and Motivation Group	213.83±154.43	160.54±75.46	-2.120**	**0.034**
BUN				
Control Group	15.43±9.09	16.77±7.23	-0.169*	0.867
Reminder Group	14.37±6.16	14.47±5.65	1.029*	0.315
Information and Motivation Group	14.01±3.87	14.10±4.06	-0.494*	0.624
Creatinine				
Control Group	0.86±0.31	0.91±0.28	-1.350*	0.184
Reminder Group	0.83±0.34	0.89±0.42	-1.914**	0.056
Information and Motivation Group	0.76±0.15	0.79±0.18	-2.472*	**0.018**

*= Dependent Group T Test was used

** =Wilcoxon Test was used

Upon questioning the opinion of the patients about the messages sent, 76.7% of the "Reminder" group said the SMS helped them take their medicine and 7.0% said they were annoyed by the phone messages. However, 81.4% of the patients with diabetes recommended SMS-service for medicine Reminder purposes (Table 5).

Table 5. Opinions of the diabetic patients regarding the SMS-service

Opinions of the "Reminder" group regarding the SMS-service	n	%
The SMS helped me to regularly take my medicine	33	76.7
I was annoyed by receiving the SMS	3	7.0
I recommend sending diabetes patients reminder SMS	35	81.4
Opinions of the "Information and Motivation" group regarding the SMS-service	**n**	**%**
It increased my treatment compliance	32	69.6
It should contain more detailed information	33	71.7
It should contain more motivational content	28	60.9
I recommend sending diabetes patients messages with information	39	84.8
I recommend sending diabetes patients motivational messages	35	76.1

Upon questioning the opinions of the patients in the "Information and Motivation" group regarding the SMS-service, 69.6% said that the SMS helped them to comply with the treatment, 71.7% stated that the phone messages should contain more information, and 60.9% said that the messages should contain more motivational content. While 84.8% of the patients in the "Information and Motivation" group recommended sending informational messages to diabetes patients, 76.1% said that motivational messages should be sent (Table 5).

Table 6. Effect of SMS intervention on biochemical parameters in the present study and other studies

	Reminder Group	Information and Motivation Group	Sezgin et al. (31)	Zolfaghari et al. (24)	Yoon et al. (32)	Shetty et al. (23)n = 110
FBS	0	0	-		0	-
HbA1c	0	0	-	-	-	0
Total cholesterol	0	0	0		0	-
HDL	0	+	+		0	0
LDL	0	0	0			-
Triglycerides	0	-	0		0	-
BUN	0	0				
Creatinine	0	+				

(0)= No significant difference before and after the intervention.

(-)= Significant decrease after the intervention

(+)= Significant increase after the intervention

DISCUSSION

In this study, we aimed to improve the lifestyle, health belief, treatment compliance, and biochemical measurement results of diabetes patients by sending SMS.

Evaluation of the effect of the SMS intervention on lifestyle changes

This study concentrated on diet and physical exercise as lifestyle changes. Previous studies showed weight loss and an increase in physical exercise due to SMS intervention in groups with and without diabetes. A study conducted in Korea with 927 patients showed that they lost a significant amount of weight with the help of weekly supporting SMS (19). Another study with 125 overweight individuals showed that the group with phone intervention lost a significant amount of weight in comparison to the control group (20). A study conducted with women after they gave birth stated that those women in the SMS intervention group showed a significant increase in physical exercise time (21).

In studies conducted with diabetes patients, Yoo et al. (22) determined that the SMS-intervention group showed a significant weight loss. A study carried out in India showed that SMS intervention for informational and motivational purposes did not create a significant difference in terms of physical exercise and diet recommendation compliance (23). The present study determined that the patients in the "Reminder" group showed an increase in both diet and physical exercise compliance and the patients in the "Information and Motivation" group showed an increase in diet recommendation compliance. A similar study conducted in Iran (24) asked the patients to self-evaluate their compliance to diet and physical exercise recommendations and the patients in the SMS intervention group showed an increase in compliance.

While the intervention in the "Information and Motivation" group consisted of informational and motivational content, the SMS in the "Reminder" group was designed to remind the patients to take their medicine. However, although it was expected in the "Information and Motivation" group, no increase in compliance regarding physical exercise was observed. Interestingly, in addition to treatment compliance, diet and physical exercise compliance increased in the "Reminder" group. This is thought to be because the number of messages sent to the "Reminder" group was higher and the messages had a general effect to remind the patients to comply with treatment.

Evaluation of the SMS intervention on Health Belief

Health belief is an important element in the development of health behaviors and this study evaluated the Health Belief Model in Diabetes Scale. A study by Kartal et al. conducted in Turkey with the same scale showed that a planned educational program increased the total score of the Health Belief Model in Diabetes Scale and all subdimensions in patients with type 2 diabetes (18). A study by Bayat et al. in 2013 showed that the perceived barriers score decreased after planned education and that all other subdimension scores and the health belief increased (25). These studies show that planned education based on the Health Belief Model affect health belief. In the present study, in contrast to these studies, the intervention within the framework of the Health Belief Model and Social Cognitive Theory was done by SMS and not by a training program. A significant increase in health belief and all subheadings, including perceived barriers, was observed in the "Information and Motivation" group that received SMS content regarding information and motivation, similar to those studies conducted with educational programs. Even though no significant increases were observed in a study where health beliefs of patients with diabetes was evaluated with SMS intervention, there was a rising trend regarding health belief and subheadings in the intervention group (26).

The perceived severity score in all three groups showed a significant increase in the present study. Although the contents of the messages sent to the "Information and Motivation" group are motivating and supportive, the increase in perceived severity score suggests that health belief is influenced not only by the content of the message, but also by the reminder stimulus.

The present study showed a significant increase in perceived benefits and recommended health related activities scores in the "Reminder" group after the intervention. Although the messages sent to the "Reminder" group were only meant to remind the patients to take their medicine, this observed increase suggests that the intervention content was effective in changing the health belief. Because health belief is a dynamic process, changing the health belief through SMS causes the individual to reassess his health belief by changing his perspective on his illness. We believe that the dynamic process here also caused health belief changes independent of the intervention content.

According to Bandura, technological developments increase the scope and effect of health development programs, but this does not mean that this communication

guarantees better health results. To achieve effective results, it is necessary to intervene with social cognitive factors known to affect health behavior (11). While all parameters of the Health Belief Model in Diabetes Scale were affected in the "Information and Motivation" group of the present study, not all parameters showed changes in the "Reminder" group. This is thought to be due to the messages about positive health perception, based on Social Cognitive Learning Theory, sent to the "Information and Motivation" group.

Evaluation of the effect of the SMS intervention on medical treatment compliance

The medical treatment compliance increased in the "Reminder" group, but there was no statistical difference in the other groups. When examining studies where diabetes patients were reminded with SMS regarding their medicine, Vervolet et al. observed that 42.9% of the patients showed an increase in medication awareness (27). Zolfaghari et al. (24) also reported that SMS contributed to the medical treatment compliance of individuals.

The present study did not show a statistical increase in the "Information and Motivation" group, but there was a rising trend. A meta-analysis conducted by Thakkar et al. in 2016 showed that SMS intervention not only increases treatment compliance, but also that the message content does not create a difference (28). The present study similarly showed that the treatment compliance was affected independently from the message content.

In the present study, 76.7% of the patients in the "Reminder" group stated that the phone messages helped them to comply with the medical treatment and 81.4% recommended sending SMS to diabetes patients for Reminder purposes. While 69.6% of the "Information and Motivation" group said that their treatment compliance increased, a significant number of patients stated that they recommend sending information and motivation messages to people with diabetes. The study of Hussein et al. (29) similarly stated that all patients said that the SMS service helped them.

Evaluation of the SMS intervention on metabolic values

With the widespread and easy use of mobile technologies, various studies have been conducted using mobile devices in order to evaluate their effect on biochemical parameters in people with diabetes (28,30). Although the biochemical parameters measured in the studies differ, HbA1c was measured in all studies. HbA1c, which increases in parallel to blood sugar, is associated with diabetes complications because of its lack of oxygen transport function and is considered an important indicator of treatment compliance (4). Some studies evaluating the effect of SMS intervention on biochemical parameters in diabetes patients and the effect of intervention are shown in Table 6.

Hussein et al. (29), Yoo et al. (22), Zolfaghari et al. (24), Yoon et al. (31), and Sezgin et al. (32) determined a decrease in HbA1c value after the intervention. Hanauer et al. (33) did not observe any difference in HbA1c value after the intervention. In the present study, the HbA1c value was, although not statistically significant, lower in the "Reminder" and "Information and Motivation" groups after the intervention. Shetty et al. (23) observed, similar to the present study, a clinical decrease in HbA1c in the intervention group, although it was not statistically significant.

No significant differences regarding the FBS values before and after the intervention were determined in the present study. There are studies showing that FBS decreased in mobile phone intervention studies (23,32,34), but there are also studies in which no significant difference was found (31,35). FBS is a short-term indicator and can be affected by food consumed 8-10 hours prior to measurement (4). Therefore, the differences observed between the studies in FBS are short-term changes originating from the patients.

When examining the lipid profiles of the SMS intervention groups, there was no significant difference before and after treatment in the "Reminder" group but there was a significant increase in HDL value and a significant decrease in triglycerides value after the intervention in the "Information and Motivation" group. Sezgin et al. (32) observed, similar to the present study, an increase in HDL value and Shetty et al. (23) observed a decrease in triglycerides value.

In the present study, HbA1c and FBS values of the individuals in the "Information and Motivation" and "Reminder" groups decreased, although it was not statistically significant, but no difference was observed in the "Control" group. This decrease observed in FBS and HbA1c can be considered not only because of increased compliance with drug treatment, but also because of the changed health perception of the patients.

Patients make sense of their symptoms and medical conditions from the perceptions they form of the disease (36). After the patients were asked to evaluate their own health status, no significant difference could be

determined in the "Control" and "Reminder" groups before and after the study, but a higher score was observed in the "Information and Motivation" group after the intervention. We think that this is because motivating messages sent to the "Information and Motivation" group caused a change in the perception of disease and a decrease in the symptom burden they perceived.

The SMS sent to diabetes patients positively affected their health belief and treatment compliance. Using all parameters of the Health Belief Model Scale in the "Information and Motivation" group showed that this effect was due to the messages that aimed at a positive health perception. In addition, because some parameters changed in the "Reminder" group, the effect also could be independent from the contents of the SMS. In conclusion, SMS interventions are easy and effective interventions that can be used to improve positive health behaviors and positive health perception in patients. Such interventions, especially for common diseases such as diabetes, will make a significant contribution to the control and treatment of the disease because of the continuity of education, decreased burden on health personnel, and access to all segments of society.

Limitations of the study

In this intervention type study, the expected participant loss for prospective studies was observed. After calling the patients who were excluded from the study because they did not come to their follow-up appointments, we learned they had their check-ups at other health institutions outside the hospital where our study was conducted. Accessing the laboratory results of the patients through an online system, independent of the health institution, will help to reduce data loss in future studies.

Declarations

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This study was approved by the clinical research ethics committee of the Afyon Kocatepe University (Date: 02.12.2016 number: 60).

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