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ORIGINAL RESEARCH

Efficiency of Using Nutritional and Exercise Applications in the Treatment of Diabetes Patients

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Abstract

Objective and Aim

Diabetes mellitus is an important public health problem whose prevalence has increased in recent years. The use of smartphone applications in the self-management of patients is becoming widespread. In this study, we aimed to investigate the effectiveness of these applications in weight loss and HbA1c level by using one of the smartphone applications in addition to the existing treatments in patients with Type 2 diabetes mellitus.

Material and Methods

This is a prospective, randomized controlled study in patients over the age of 18, with type 2 diabetes mellitus, with an HbA1c level of 7-10% and a body mass index of 30-40, who applied to the Erciyes University Faculty of Medicine (EUTF) Family Medicine Department (AD) outpatient clinic and Endocrinology and Metabolism outpatient clinic between September 2019 and December 2020.The patients were followed for 6 months.42 patients, 21 in the control group and 21 in the intervention group, completed the study. A nutrition-exercise behavior scale was applied to both groups, and a phone application was installed on the intervention group where they could record their diet and physical activities. Interviews were held with the patients every two weeks for the first two months and then every month.

Results

The BMI and weight of the patients were evaluated every 2 weeks until the eighth week, and every four weeks thereafter. BMI and weight changes evaluated within 24 weeks in the intervention and control groups were analyzed. In the intervention group, BMI and weight decreased in 95.2% (n=20) and increased in 4.8% (n=1) compared to baseline at week 24. In the control group, it decreased in 57.1% (n=12), increased in 33.3% (n=7) and remained the same in 9.5% (n=2). The proportion of those whose BMI and weight decreased in the intervention group was significantly higher than the control group. When the change in HbA1c percentages was compared, the change in HbA1c in the intervention group was significantly higher than in the control group.

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Conclusion

In our study, it has been shown that supporting self-management with mobile health applications can provide significant changes and better glycemic control in reducing body weight, body mass index and HbA1c in patients with type 2 diabetes mellitus. More positive results can be obtained by adding mobile applications to the standard follow-ups of diabetes patients.

This cross-sectional study was conducted between 15 April and 15 June 2025 at Akkapi No. 2 Family Health Center, Seyhan, Adana, Türkiye. A total of 120 registered patients with T2DM (out of 254 registered diabetic patients) were included after sample size calculation. Data were collected via a comprehensive questionnaire covering demographic characteristics, lifestyle and dietary habits, treatment adherence, healthcare utilization, and perceived glycemic control. Laboratory results, including HbA1c, were obtained from patient records. Statistical analyses were performed using SPSS 23; p<0.05 was considered significant.

Keywords: Type 2 Diabetes Mellitus, Mobile Application, Lifestyle Changes

1. Introduction

Type 2 Diabetes Mellitus (DM) is an important health problem in the society with an increasing prevalence in the world and in our country. This increase is due to the increase in factors such as obesity, unhealthy diet, and widespread physical inactivity (1).

According to the International Diabetes Federation (IDF), it is estimated that 463 million adults aged 20-79 have diabetes in 2019, 578 million by 2030 and 700 million by 2045. The prevalence of diabetes in the world is 9.3% in the age range of 20-79 (2). According to the IDF, Turkey is the country with the highest diabetes prevalence in Europe and is the 3rd country with the highest diabetes population in Europe (3). Overweight and obesity are very strongly associated with type 2 diabetes (4). Studies have shown that obesity is involved in the etiology of more than 80% of type 2 diabetes cases (5). Apart from type 2 diabetes and prediabetes, obesity is also a risk factor for cardiovascular diseases, musculoskeletal disorders, and some cancers (6). In a meta-analysis, when obese people from the United States and Europe were compared to normal-weight people, obese men were 7 times more likely to develop type 2 diabetes and obese women were 12 times more likely (7). In obese individuals with diabetes, a significant improvement in blood sugar control is observed with 5-15% weight loss (5).

Emphasis on glycemic control and self-management of other risk factors, along with pharmacological therapy, may be beneficial in improving the prognosis of diabetes. Medical nutrition therapy is the most effective intervention for lifestyle and behavioral changes in providing glycemic control in patients with type 2 diabetes (8). Although self-management is traditionally offered through face-to-face training, this resource is costly and intensive. Advances in mobile technology provide patients with easily accessible and potentially cost-effective self-management support (9,10). Patients can keep daily diet and exercise records through mobile applications. It has been shown that electronic record diaries are more effective in compliance with diet and weight control than traditional nutrition diaries kept on paper (11). Despite the potential of smartphones and mobile applications and the increase in their use in society, few randomized controlled clinical trials (RCT) have been published examining the effectiveness of these technologies (12). The aim of this study is to investigate the effectiveness of these applications in weight loss and HbA1c level by using one of the smartphone applications in addition to their existing treatments in type 2 diabetes patients.

2. Matherial and Methods

This study started with the approval of

Erciyes University Ethics Committee dated 22.05.2019 and numbered 2019/376. Patients over the age of 18 with type 2 diabetes mellitus diagnosed in Erciyes University Faculty of Medicine, Family Medicine Outpatient Clinic and Endocrinology and Metabolism Polyclinic, between September 2019 and December 2020 were included in the study. It is a prospective randomized controlled intervention study. A mobile phone application called Samsung Health was used for the intervention. We aimed to investigate the effectiveness of the smartphone application on blood sugar regulation and weight control in type 2 diabetes patients.

51 patients diagnosed with Type 2 diabetes who applied to the outpatient clinic for any reason were included in the study and were divided into two groups. It has been studied in patients with HbA1c in the range of 7-10, body mass index (BMI) ≥30 kg/m2 and <40 kg/m2, using insulin and oral antidiabetic or oral antidiabetic only. Patients were randomly assigned to an intervention group and a control group, respectively. Twenty-five patients were included in the control group and twenty-six patients were included in the intervention group. 4 patients in the control group and 5 patients in the intervention group were excluded from the study because they could not be reached during the controls. The patients who accepted the study signed the consent form and filled out the questionnaire (including sociodemographic data and information about diabetes) and the nutrition exercise behavior scale. Physical examinations of both intervention and control group patients were performed, and body mass index was calculated by looking at instant height and weight. The HbA1c value was checked, and interviews involving behavior and life changes were made. The dietitian was directed and information was given about the importance of losing weight, diet and exercise. It was aimed to achieve 5-10% weight loss for the patients. It was recommended to walk at a moderate pace every day if possible, and if not every day, no more than two days between two exercises. They were told that they should increase their exercise duration by increasing their activity tempo, frequency and/or duration over time, at a moderate pace of at least 150 minutes/week. In addition to the intervention group, a smartphone application called "Samsung Health" was installed and they were asked to record what they ate, drank and exercised every day on this application. A total of nine follow-ups were planned for both groups, once every two weeks for the first two months and once a month for the following months, and an appointment was made to meet face-to-face or over the phone. At the end of the study, he was called to the outpatient clinic to have his HbA1c values checked. The study was planned as 24 weeks.

Body mass index was calculated by looking at body weight at each interview. The type and duration of exercise were evaluated at each interview according to the patient's lifestyle and BMI, and changes were made when necessary. The intervention group was encouraged to use the application in each interview and the application records were examined.

Nutrition-Exercise Behavior Scale: It is the Nutrition-Exercise Behavior Scale (NEBS) developed by Yurt and Save in 2005 to determine nutritional and exercise behaviors. It was developed in Turkish. NEBS is a five-point Likert-type scale consisting of 45 items and four sub-factors. The Cronbach's Alpha coefficient, which gives the internal consistency of the items forming the scale and, in a sense, evaluates its reliability, was found to be 0.85. It has been shown to be highly reliable. The NEBS scale retest was evaluated with the Wilcoxon Signed Ranks test. It was concluded that there was no significant difference between the two measurements (p=0.11) and that the measurement tool was reliable (13).

Samsung Health app: The app is free, easy to download on most smartphones, and easy to register and use. We preferred this application in order to increase the motivation of the patient and to keep the diet and exercise records of the patient regularly. On the main screen of the program, there are

Table 1: Comparison of application group and control group patients in terms of sociodemographic characteristics

Feature		Application group (n=21)	Control group (n=21)	p
Age (years)	Mean ± SD	56,2 ± 8,3	58,1 ± 9,6	0,519†
Gender	N (%)			0,001††
	Woman	6 (28,6)	17 (81,0)	
	Male	15 (71,4)	4 (19,0)	
Marital status	N (%)			0,500*
	Married	20 (95,2)	19 (90,5)	
	Single	1 (4,8)	2 (9,5)	
Residence	N (%)			0,368††
	Village/town/country	1 (4,8)	1 (4,8)	
	Province	20 (95,2)	20 (95,2)	
Educational status	N (%)			0,005††
	Elementary and below	5 (23,8)	14 (66,7)	
	High school and above	16 (76,2)	7 (33,3)	
Profession	N (%)			-
	Officer	4 (19,0)	1 (4,8)	
	Housewife	6 (28,6)	16 (76,2)	
	Self-employment	4 (19,0)	1 (4,8)	
	Diğer	7 (33,3)	3 (14,3)	
Social security	N (%)			0,287††
	Bağ-kur	0	2 (9,5)	
	SSK	16 (76,2)	16 (76,2)	
	Pension fund	5 (23,8)	3 (14,3)	
Income status	N (%)			0,238*
	Income>Expence	19 (90,5)	15 (71,4)	
	Expence>Income	2 (9,5)	6 (28,6)	
Number of people in the household	Mean ± SD	3,1 ± 1,0	2,7 ± 0,8	0,272†
Smoking (+)	N (%)	2 (9,5)	0	0,293††
Alcohol (+)	N (%)	0	0	-

*†t T-test independent groups, ††Chi-square test, *Fisher's Exact test.*

menus for goal setting, number of steps, running, food and weight. With the manage items button, different features can be added on the main screen (Sleep, water consumption, 84 different exercise types). In the goal setting part, the person enters the daily activity and calorie goals into the program. A person can track his/her weight by manually entering his/her weight into the program. BMI can be calculated by manually entering height in user information. By clicking on the 'add food' option on the main screen, the person can record what they eat for main and snack meals. By clicking on the meal he wants to add, he can write the food he ate in the search tab and save it. By clicking on the food he has chosen, he can reach the detailed nutritional content (calorie, protein, carbohydrate, fat ratio, fiber, vitamin content, etc.). The program automatically records the daily number of steps, so that the person can follow the activity goal he has set from the main screen. At the same time, you can see the calories burned.

Statistical analyzes were performed using the SPSS version 21.0 (IBM®, Chicago, USA) package program. The conformity of the variables to the normal distribution was examined using visual (histogram and probability graphs) and analytical methods (Shapiro-Wilk test). Descriptive statistics were expressed as mean and standard

Table 1. Comparison of application group and control group patients in terms of diabetes and diet-related characteristics

Feature		Application group (n=21)	Control group (n=21)	p
Diabetes duration	Med(min-max)	8 (1-20)	14 (2-20)	0,126†
Oral Antidiabetic (+)	N (%)	18 (85,7)	18 (85,7)	1,000††
Insülin (+)	N (%)	15 (71,4)	17 (81,0)	0,469*
Family history of DM (+)	N (%)	10 (47,6)	5 (23,8)	0,107*
Sports (+)	N (%)	7 (33,3)	4 (19,0)	0,292*
Those who are uncomfortable with their weight (+)	N (%)	13 (61,9)	14 (66,7)	0,747*
Weight loss attempt (+)	N (%)	14 (66,7)	13 (61,9)	0,747*
Number of meals	N (%)			0,412*
	2/day	3 (14,3)	5 (23,8)	
	3/day	18 (85,7)	15 (71,4)	
	4/day	0	1 (4,8)	
Skipping meals (+)	N (%)	9 (42,9)	7 (33,3)	0,525*
Snack (+)	N (%)	16 (76,2)	19 (90,5)	0,410††

*†Mann-Whitney U test, ††Fisher's Exact test * Chi-square test*

deviation in normally distributed numerical data, median and minimum-maximum range in non-normally distributed data, number and percentage in nominal data. Normally distributed numerical variables were analyzed with the "T test in Independent Samples" between the two groups, and numerical variables that did not show normal distribution were analyzed with the "Mann Whitney U test" between the two

groups. Nominal data were evaluated between the two groups using the Pearson Chi-square test or Fisher's Exact test. "Spearman correlation test" was used for correlation analysis. Comparisons with a p value below 0.05 were considered statistically significant in the statistical analyzes in the study.

Results

The mean age of the patients was 57.2 ± 9.0 years (34-75 years). 54.8% (n=23) of the patients were female and 45.2% (n=19) were male. The mean HbA1c levels of the patients were 8.12 ± 0.84 before the study and 7.61 ± 0.95 at the end of the study. The BMI and weight of the patients were evaluated every 2 weeks until the eighth week and every 4 weeks thereafter. The BMI and weight of the patients were followed up to the 6th month. At 24th week, BMI and weight decreased in 76.2% (n=32) of the patients, while BMI and weight increased in 19.0% (n=8). It remained the same in 4.8% (n=2).

Application group and control group patients were compared in terms of demographic characteristics. The two groups were similar in terms of mean age (p=0.519), but the frequency of female gender was significantly higher in the control group (p=0.001). In addition, the education level was significantly higher in the application group than in the control group (p=0.005). No significant difference was observed between the groups in terms of other sociodemographic characteristics (Table 1).

Application and control group patients were compared in terms of diabetes and diet-related characteristics. No significant difference was observed between the groups (Table 2).

BMI and weight changes evaluated within 24 weeks in the application and control groups were analyzed within the group. In the application group, the 2nd week BMI mean was significantly lower than the 0th week (p<0.001), the 4th week BMI mean was significantly lower than the 2nd week (p=0.013), the 6th week BMI mean was

Table 2. Intragroup analyzes of BMI and weight changes in the application and control groups

	Application	Control	Application	Control
	BMI		Weight	
0 week	33,2 ± 2,5	34,3 ± 2,9	94,8 ± 10,8	83,8 ± 9,4
2nd week	32,9 ± 2,5	34,2 ± 2,9	93,9 ± 10,5	83,6 ± 9,2
p	<0,001	0,107	<0,001	0,073
4th week	32,5 ± 2,6	34,1 ± 2,9	92,7 ± 9,7	83,5 ± 90,422,3
p	0,013	0,590	0,029	0,422
6th week	32,2 ± 2,6	34,0 ± 3,0	92,1 ± 9,7	83,1 ± 9,2
p	0,003	0,067	0,003	0,045
8th week	32,0 ± 2,6	34,0 ± 3,2	91,3 ± 9,9	83,2 ± 9,3
p	0,010	0,550	0,002	0,449
12th week	31,8 ± 2,6	34,0 ± 3,2	90,8 ± 9,9	83,2 ± 9,3
p	0,005	0,631	0,001	0,884
16th week	31,7 ± 2,6	34,0 ± 3,0	90,4 ± 9,9	83,2 ± 9,2
p	0,071	0,685	0,064	0,883
20th week	31,3 ± 2,5	34,1 ± 3,0	90,6 ± 9,0	83,3 ± 8,8
p	0,003	0,656	0,003	0,833
24th week	31,2 ± 2,6	34,2 ± 2,9	90,3 ± 9,0	83,7 ± 8,5
p	0,220	0,696	0,195	0,631

**Paired t-test was used in all analyses.*

significantly lower than the 4th week (p=0.003), the 8th week BMI mean was significantly lower than the 6th week (p=0.010), the 12th week BMI mean was significantly lower than the 8th week (p=0.005), the 20th week BMI mean was significantly lower than the 16th week (p=0.003). In addition, the mean BMI at week 24 was significantly lower than the mean BMI at week 0 (p<0.001). There was no significant change in the mean BMI between weeks 0-24 in the control group. There was no significant difference between the mean BMI at week 24 and the mean BMI at week 0 (p=0.281).

In the application group, the mean weight of the 2nd week was significantly lower than the 0th week (p<0.001), the 4th week mean weight was significantly lower than the 2nd week (p=0.029), the 6th week mean weight was significantly lower than the 4th week (p=0.003), the 8th week mean weight was significantly lower than the 6th week (p=0,002). The mean weight of the 12th week was significantly lower than the 8th week (p=0.001). 20th week mean weight was significantly lower than the 16th week (p=0.003). In addition, the mean weight at week 24 was significantly lower than the mean weight at week 0 (p<0.001). In the control group, a significant decrease was observed only between the 6th and 4th weeks only (p=0.045). However, there was no significant difference between the mean weight at week 24 and mean weight at week 0 (p=0.211).

Table 3 shows the changes and analyzes observed in the mean BMI and weight in the application and control groups.

Table 3. The final status and analysis of BMI and weight between 0-24 weeks in the application and control groups

		Application group (n=21)	Control group (n=21)	p
BMI and weight between 0-24 weeks	N(%)			0,014†
	Increments	1 (4,8)	7 (33,3)	
	Descendants	20 (95,2)	12 (57,1)	
	Those who stay the same	0	2 (9,5)	

† Chi-square test

In the application group, BMI and weight decreased in 95.2% (n=20) of the patients and increased in 4.8% (n=1) compared to baseline at week 24. In the control group, it decreased in 57.1% (n=12) of the patients, increased in 33.3% (n=7), and remained the same in 9.5% (n=2). The rate of those whose

Table 4. Change and comparison of HbA1c, BMI and weight in the application and control groups

Feature		Application group (n=21)	Control group (n=21)	p
HbA1c (%)	Mean ± SD			
Before work		8,2 ± 0,8	7,9 ± 0,8	0,297†
After work		7,5 ± 0,8	7,7 ± 1,0	0,497†
p		0,001*	0,384*	
ΔHbA1c (%)	Med (min-max)	0,81 (-1,0-3,1)	0,3 (-1,1-1,4)	0,041††
BMI (kg/m2)	Mean ± SD			
0 week		33,2 ± 2,5	34,3 ± 2,9	0,215†
2nd week		32,9 ± 2,5	34,2 ± 2,9	0,145†
4th week		32,5 ± 2,6	34,1 ± 2,9	0,063†
6th week		32,2 ± 2,6	34,0 ± 3,0	0,054†
8th week		32,0 ± 2,6	34,0 ± 3,2	0,032†
12th week		31,8 ± 2,6	34,0 ± 3,2	0,016†
16th week		31,7 ± 2,6	34,0 ± 3,0	0,010†
20th week		31,3 ± 2,5	34,1 ± 3,0	0,004†
24th week		31,2 ± 2,6	34,2 ± 2,9	0,002†
ΔVKİ (kg/m2)	Med (min-max)	1,8 (-0,6-4,3)	0,3 (-1,5-2,0)	<0,001††
Kilo (kg)	Mean ± SD			
0 week		94,8 ± 10,8	83,8 ± 9,4	0,001†
2nd week		93,9 ± 10,5	83,6 ± 9,2	0,002†
4th week		92,7 ± 9,7	83,5 ± 9,3	0,003†
6th week		92,1 ± 9,7	83,1 ± 9,2	0,004†
8th week		91,3 ± 9,9	83,2 ± 9,3	0,010†
12th week		90,8 ± 9,9	83,2 ± 9,3	0,013†
16th week		90,4 ± 9,9	83,2 ± 9,2	0,020†
20th week		90,6 ± 9,0	83,3 ± 8,8	0,017†
24th week		90,3 ± 9,0	83,7 ± 8,5	0,024†
ΔWeight (kg)	Med (min-max)	5 (-2-15,2)	1 (-3,6-7,0)	<0,001††

*†Independent samples t-test, *Peared t- test, ††Mann Whitney U test*

BMI and weight decreased in the application group was significantly higher than the control group (p=0.014) (Table 4).

In the application group, the mean HbA1c was 8.2% ± 0.8 before the study and 7.5% ± 0.8% at the end of the study. At the end of the study, a significant decrease was observed in the mean of HbA1c (p=0.001). In the control group, it was 7.9 ± 0.8% before the study and 7.7 ± 1.0% at the end of the study. There was no significant decrease in HbA1c level in the control group (p=0.384). The mean HbA1c levels between the application and control groups were similar before the study (p=0.297) and after the study (p=0.497). When the changes in HbA1c percentages were compared, the change in HbA1c in the application group was significantly higher than in the control group (p=0.041).

In the application group, a median decrease of 1.8 kg/m2 was observed in BMI value within 0-24 weeks, while a median decrease of 0.3 kg/m2 was observed in the control group. The amount of decrease observed in BMI values in the application group was significantly higher than the control group (p<0.001). While the mean weight of the application group decreased by 5 kg in 0-24 weeks, it decreased by 1 kg in the control group. The decrease observed in the application group was significantly higher than the control group (p<0.001).

Table 5 shows the analysis of HbA1c, BMI and weight changes observed in the application and control groups.

Table 5. Distribution and analysis of NEBS scores in the application and control groups

NEBS		Application group (n=21)	Control group (n=21)	p
		Mean ± SD	Mean ± SD	
Psychological/addicted eating behavior score		29,5 ± 7,3	33,2 ± 8,1	0,129
Healthy eating and exercise behavior score		48,4 ± 5,0	46,9 ± 6,8	0,433
Unhealty eating and exercise behavior score		33,9 ± 5,0	35,4 ± 5,1	0,350
Meal order score		27,6 ± 3,1	27,8 ± 3,5	0,891

**Independent samples t-test was used in all analyses*

NEBS scores in the application and control groups were compared. No significant difference was observed in terms of "Psychological/addictive eating behavior" score (p=0.129), "healthy eating and exercise behavior" score (p=0.433), "unhealthy eating and exercise behavior" score (p=0.350) and "meal order" score (p=0.891) between the two groups (Table 6).

Discussion

In our prospective design study, a significant decrease was observed in BMI, body weight and HbA1c levels in the application group in patients followed for 6 months. While a decrease in BMI was observed in 95.2% of the patients in the application group, a decrease was observed in 57.1% of the control group. The decrease in HbA1c, BMI and body weight in the application group was more pronounced than in the control group. Therefore, in our study, it was thought that the use of the application helped to achieve better glycemic control in patients with diabetes mellitus, resulting in a more significant reduction in BMI and body weight.

Although there are different applications, patient follow-up times, and study designs, results supporting our findings on application use have been reported previously. In the study of Orsama et al. (14), an automatic telephone feedback system and mobile-based remote patient reporting system/application were developed under the guidance of health behavior change theory in order to improve the health status and self-management of patients with type 2 diabetes mellitus. This application was recommended to 24 diabetic patients, and the control group consisting of 24 diabetes patients continued their standard treatment. After an average follow-up of 10 months, a greater reduction in HbA1c level and body weight was observed in the intervention group. These findings were consistent with our study. In the study of Orsama et al., unlike our study, patients received feedback from the records they entered into the created mobile application and were followed up with a more complex and sophisticated system.

Quinn et al. (15) followed 30 diabetic patients for 3 months in their study using the "WellDoc" application. In the study, it was observed that the decrease in HbA1c levels was more pronounced compared to the control group. Unlike our study, this application gave real-time feedback on the patient's blood glucose level, showed the patient's treatment regimen to the clinician, and included hypoglycemia-hyperglycemia treatment algorithms. For this reason, the proportion of patients whose treatments were changed among the patients in the intervention group during the treatment was found to be higher than the control group, and the physicians of the intervention group reported that the practice facilitated their treatment decisions.

In a very recent study by Yang et al. (16), diabetes patients in the intervention group were asked to load their blood glucose levels daily for 3 months through a mobile application. The blood glucose levels loaded by the patients were examined by the clinicians and a feedback message was sent to the patients once a week. At the third month, HbA1c and fasting blood glucose levels were better in the intervention group. These findings supported our results, but the mobile health application used in our study aimed to increase the self-management of patients and to follow them more closely, rather than interfering with their treatment. In addition, in our study, unlike the study of Yang et al. (16), physical activity levels and body weights of the patients were also followed regularly.

13 randomized studies and a total of 1022 patients were included in the meta-analysis conducted by Cui et al. (17) in 2016. In the meta-analysis, it was stated that mobile health applications provided a significant reduction in HbA1c levels, but had no effect on blood pressure and lipid levels. In a meta-analysis conducted by Wang et al. (18) in 2020, although the effectiveness of mobile health applications varies greatly between studies, it was found that mobile health applications are a viable option in most studies and have a significant potential in improving the health of patients compared to standard care, especially in glycemic control has been reported.

Increasing the participation of patients in treatment may have mediated the results we obtained with the mobile health application. Better clinical results can be obtained with the participation of diabetic patients in the treatment or follow-up process. In the study of Parchman et al. (19), it was stated that more successful improvements were observed in HbA1c and LDL-cholesterol levels by including diabetes patients in the treatment process in primary health care services. On the other hand, mobile health applications may have increased the frequency of follow-up of patients. More frequent patient follow-ups are associated with glycemic control (20).

In the literature, it has been reported that positive clinical results have been obtained with many applications in diabetes mellitus patients. In addition to generic applications, specific applications have been developed for diabetes patients. For this purpose, the "Few Touch" application was developed in 2010. In this application, it combines the phone with a blood glucose meter, includes software for step counter and eating habits. In the first studies in which this system was used, it was stated that it had a motivational effect (21). Afterwards, mobile health applications started to be developed more and more frequently (22). It has been stated that an ideal application developed for diabetes should include automatic transfer of blood glucose data, enabling short messages for patient education, diabetes diary, integration of patient diary into health services, physical activity and weight monitoring, nutritional information and blood glucose targets (23). By integrating diabetes-specific mobile applications into the health system, patients can be followed more closely and closely, more effective glycemic control can be achieved, and patients with whom glycemic control cannot be achieved can be diagnosed earlier.

There was no difference between the application group and the control group in terms of duration of diabetes, rates of patients using oral anti-diabetic or insulin, and skipping meals. The fact that the groups were similar in terms of these factors allowed us to exclude factors that would affect the results. However, in our study, it was observed that gender and education level were different between the application group and the control group. It was observed that the frequency of male gender was higher in the application group. In addition, the education level of the application group was higher. The relationship between the use of online resources and the level of education has been known for a long time. In the study of Carroll et al. (24), it was stated that mobile health applications are used less frequently if the education level is low.

In our study, in addition to the glycemic control of the patients and the change in body weight, the number of meals, the frequency and reason for skipping meals, the frequency and content of snacks were also questioned. All patients who were followed up for six months were given the necessary training and information about the diabetes diet during their follow-up. In addition, at the beginning of the study with the "Nutrition and Exercise Behaviors Scale", the patients were questioned in terms of their psychological eating behaviors, healthy and unhealthy nutrition and exercise behaviors, and meal order. In our study, it was shown that there was no difference between the application and control groups in terms of nutrition and exercise behaviors with this scale used in the evaluation of diabetes patients. For this reason, factors that may have an impact on the results we obtained with the use of mobile health applications were excluded.

Research Strengths

The fact that it is a randomized, controlled-type intervention study makes our research powerful. Thanks to the mobile application and frequent meetings, patients have been more involved in the treatment process. It can be said that mobile applications provide better self-management. It has been shown to positively affect weight loss and improve glycemic levels. Telephone and face-to-face interviews increased the rate of participants using the application. Participants were encouraged to use the application by examining and evaluating the application records at each visit of the intervention group. In this way, self-management skills were increased by enabling them to follow themselves. The fact that the diet and exercise behaviors of the intervention and control groups were similar at the beginning of the study enabled the exclusion of factors that would affect our results. Since there are few studies in the literature showing the effectiveness of mobile applications in interventions such as nutrition and physical activity in type 2 diabetes self-management, it is thought that our study will contribute to the literature.

Limitations of the Research

It can be said that the number of patients included in our study was partially small. The mobile application used in our study aimed to improve the patients' own follow-up. However, the effectiveness of both the follow-up and intervention of patients has been reported in the literature. However, data on the advantages of applications are limited. Therefore, it can be said that our findings are related to the effectiveness of mobile applications that enable the development of patient follow-up. In addition, in our study, the number of men and those with higher education levels were higher in the group using mobile applications. This may have affected our results.

Conclusion

The use of mobile health applications is increasing. These applications, which aim to protect the well-being of healthy individuals, can be useful in the follow-up of chronic diseases. For this purpose, the mobile health application was used in the follow-up of diabetes patients in our study, and the patients themselves followed the number of meals, meal contents, body weights, physical activities and daily step counts with this application. After 6 months of use of the mobile health application, it was observed that the decrease in HbA1c, BMI and body weight was more pronounced when compared to the control diabetes patients who received their standard treatments. Our findings indicated that better glycemic control could be achieved by supporting the self-management of patients with mobile health applications.

Self-management of diabetes patients can be increased with mobile health applications. Monitoring of diabetes patients with mobile health applications has a positive effect on body weight and BMI. More positive results can be obtained by adding mobile health applications to the standard follow-ups of diabetes patients.

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