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The Effect of Comprehensive Tele-Education in Patients with Diabetes Mellitus: A Randomized Controlled Trial

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ABSTRACT

Aim: This study aimed to investigate the effectiveness of remote education given via telehealth to individuals diagnosed with Type 2 diabetes on exercise goals, physical activity, nutrition, medication habits and diabetes problems.

Material and Methods: A randomized controlled trial was conducted with a total of 30 patients with diabetes mellitus (15 tele-education, 15 routine education). Individuals were educated about general information about diabetes, nutrition therapy, exercise, physical activity, drug therapy, and acute/chronic complications. Participants were evaluated with the Mini Nutritional Assessment, International Physical Activity Questionnaire, Goal Orientation in Exercise Measurement, Modified Morisky Medication Adherence Scale and Problem Areas in Diabetes Scale.

Results: In terms of MNA scores, only the decrease in the score of routine rehabilitation was significant (p=0.041). The MNA score did not differ between the tele-education and routine rehabilitation groups (p>0.05). Finally, the education program did not affect the other scores (p>0.05).

Conclusion: The study results showed that tele-education can only positively affect nutrition. However, both tele-education and routine training provided similar and ineffective results. Future studies could focus on remote education programs delivered through different educational methods.

Keywords: *Health care services, Telehealth, Telemedicine, Type-2 diabetes mellitus*

Tip 2 Diabetes Mellitus Hastalarında Kapsamlı Tele-Eğitimin Etkinliği: Randomize Kontrollü Çalışma

ÖZ

Amaç: Bu çalışmada Tip 2 diyabet tanısı almış bireylere tele-sağlık yoluyla verilen uzaktan eğitimin egzersiz hedefleri, fiziksel aktivite, beslenme, ilaç alışkanlıkları ve diyabet sorunları üzerindeki etkinliğinin araştırılması amaçlanmıştır.

Gereç ve Yöntemler: Toplam 30 Diabetes Mellitus hastası (15 tele-eğitim, 15 rutin eğitim) ile randomize kontrollü bir çalışma yürütülmüştür. Bireylere diyabet hakkında genel bilgiler, beslenme tedavisi, egzersiz, fiziksel aktivite, ilaç tedavisi ve akut/kronik komplikasyonlar hakkında eğitim verilmiştir. Katılımcılar Mini Nutrisyonel Değerlendirme, Uluslararası Fiziksel Aktivite Anketi, Egzersiz Ölçümünde Hedef Oryantasyonu, Modifiye Morisky İlaç Uyum Ölçeği ve Diyabette Sorun Alanları Ölçeği ile değerlendirilmiştir.

Bulgular: MND skorları açısından sadece rutin rehabilitasyon skorundaki düşüş anlamlıydı (p=0,041). MND skoru tele-eğitim ve rutin rehabilitasyon grupları arasında farklılık göstermemiştir (p>0,05). Son olarak, eğitim programı diğer skorları etkilememiştir (p>0,05).

Sonuç: Çalışma sonuçları tele-eğitimin sadece beslenmeyi olumlu yönde etkileyebileceğini göstermiştir. Bununla birlikte, hem tele-eğitim hem de rutin eğitim benzer ve etkili olmayan sonuçlar sağlamıştır. Gelecekteki çalışmalar, farklı eğitim yöntemleri ile sunulan uzaktan eğitim programlarına odaklanabilir.

Anahtar Sözcükler: *Sağlık hizmetleri, Tele-sağlık, Teletıp, Tip-2 diabetes mellitus*

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INTRODUCTION

Diabetes mellitus is a disease that occurs due to insufficient secretion of the hormone insulin by the beta cells of the pancreas, no secretion of insulin, or a decrease in the effect of insulin due to disturbances in its metabolism (1, 2). It is a rapidly growing global problem with significant health, economic and social consequences (3).

The most common type of diabetes mellitus is Type 2 diabetes. In cases where diabetes is not adequately controlled, many future complications can be seen in organs and tissues. Diabetes not only reduces the life expectancy and quality of life of individuals but is also a fundamental cause of a series of microvascular and macrovascular complications leading to vision loss, renal failure, myocardial infarction, stroke and amputation (4).

Providing practical and cost-efficient interventions can be essential to improve the clinical condition of patients and maximize the benefit of existing healthcare budgets (5, 6). The use of telehealth technologies in healthcare is becoming increasingly widespread (6-8).Telehealth has become one of the most frequently used options in recent years for rehabilitation (7). It offers people with diabetes, especially those living in rural and medically underserved areas, the opportunity to access high-quality diabetes education programs (9). Diabetes education is crucial in the rehabilitation of diabetes. Studies have shown that patients who received diabetes education improved their ability to manage the disease and their attitudes towards it (10-12).

It has been observed that the use of this telehealth approach contributes positively to the health outcomes of individuals, increases their quality of life (10), increases the level of knowledge about diabetes, decreases the rate of acute complications, increases regular blood glucose monitoring, decreases HbA1c level, increases compliance with treatment, diet compliance and regular exercise habits, and decreases diabetes-related stress (6, 8, 11). This study was planned to examine the effectiveness of remote education given via mobile phone to individuals diagnosed with Type 2 diabetes.

MATERIALS and METHODS

Study Design

A randomized controlled trial was conducted with 30 volunteer patients who were followed up by the Department of Internal Medicine (Author C.Ş.) and Family Medicine (Author E.N.Y.), Muğla Sıtkı Koçman University and diagnosed with Type 2 Diabetes between January 2022 and May 2023. The sample size calculation of this study was calculated with G-Power 3, considering the effect size of the reference study (13) with a similar design and subject in patients with Type 2 diabetes (14). As a result, the effect size value was calculated as 0.95 according to the changes in similar parameters of both groups. A total of 30 patients were calculated to be adequate with 80% power and 95% confidence level. It was determined that at least 15 cases were sufficient for both groups. The cases were divided into two groups with randomization software. The randomization was conducted by the random number generator tool. Conventional education practices were applied to the first study group. Telehealth training was applied to the second study group. The conventional education group was given data collection forms and a brochure about diabetes on the day they applied to the polyclinic. In the telehealth education group, data collection forms were applied first. Following the first interview, diabetes education videos prepared in advance, two episodes per week, were sent to the individuals' cell phones. Video delivery was completed in a total of four weeks. Mini Nutritional Assessment (MNA), International Physical Activity Questionnaire (IPAQ), Goal Orientation in Exercise Measurement (GOEM), Modified Morisky Medication Adherence Scale (MMS), and Problem Areas in Diabetes Scale were administered to the entire population at the first and second assessment. Patients in both groups were asked to complete the data collection questionnaires three months after the first interview. At the end of the second interview, diabetes education videos were sent to the individuals in the conventional education group, and they were provided with the same education.

The educational content program was created by considering the guidelines prepared by the Turkish Diabetes Foundation for patient education (15). In diabetes education content, power point presentations were prepared under the titles of what diabetes is, nutrition treatment in diabetes, exercise in diabetes, physical activity treatment in diabetes, drug treatment in diabetes, and acute/chronic complications of diabetes. These presentations were then converted into video format and sent remotely to individuals' smartphones.

Inclusion criteria were defined as individuals who had a diagnosis of type 2 diabetes mellitus for at least six months, were between the ages of 18-65, were receiving oral antidiabetic and insulin therapy, had a mobile phone with video message receiving and playback capability, had no hearing or speech problems or psychiatric problems that would prevent communication, and volunteered to participate in the study. The exclusion criteria were individuals who did not want to participate in the study. The study adhered to ethical principles and followed the Declaration of Helsinki. The study protocol was approved by the ethics committee of Muğla Sıtkı Koçman University (No:24/1, Date: 24.11.2021).

Data Collection

The data collection questioned the patient's demographics, including age, gender, educational status, marital status, occupation, duration of diabetes diagnosis, and chronic disease status. Participants completed Mini Nutritional Assessment, International Physical Activity Questionnaire, Goal Orientation in Exercise Measurement, Modified Morisky Medication Adherence Scale, Problem Areas in Diabetes Scale.

Mini Nutritional Assessment: The nutritional status of individuals was evaluated with the MNA. The MNA is a valid and reliable system that scores nutritional status in a short form (16). The psychometric properties of the Turkish versions of the long and short forms were found to be appropriate (17).

International Physical Activity Questionnaire: IPAQ was developed by Craig et al. (18). It evaluates the physical activity levels of the individuals. The Turkish clinometric study of the IPAQ was conducted by Sağlam et al. (19).

Goal Orientation in Exercise Measurement: Goal orientation in exercise measurement (GOEM) was developed by Petherick and Markland (2008) (20). The Turkish validity and reliability of this scale were conducted by Ersöz et al. in 2017. GOEM evaluates individual differences in the way people interpret success (21).

Modified Morisky Medication Adherence Scale (MMS): It is one of the most widely used scales to investigate medication adherence. The scale was developed by Morisky et al. (22) in 1986 as a four-question questionnaire to assist family physicians in assessing adherence to antihypertensive medication. The Turkish validity and reliability study of this scale was conducted by Vural et al. in 2012 (23). In the second and fifth questions, the yes answer is one point, and the no answer is zero points; in the other questions, the yes answer is zero, and the no answer is one point. If the total score obtained by the patient from the first, second and sixth questions is zero or one, it indicates a low motivation level. In contrast, values above one point indicate a high motivation level. If the total score obtained from the third, fourth and fifth questions is zero or one, it indicates a low level of knowledge, and values above one point indicate a high level of knowledge.

Problem Areas in Diabetes Scale (PAID): PAID is practical scale to assess the problem areas of the patients with diabetes mellitus. The scale is reliable and valid. Turkish version of the PAID is also validated (5, 24).

Statistical Analysis

"IBM SPSS" was used for the data analysis. Statistical significance was evaluated at the $p<0.05$ level in all analyses. Continuous variables were expressed as mean ± standard deviation, and categorical variables as number and percentage. In the decision of statistical analysis, the conformity of all data to the normal distribution was examined using the One-Sample Kolmogorow-Smirnow Test and Histogram. Parametric tests were used where the data conformed to the normal distribution, and non-parametric tests were used in cases where they did not. When the parametric test assumptions were met, the significance test of the difference between two means was used to compare independent group differences; when the parametric test assumptions were not met, the Mann-Whitney U test was used to compare independent group differences. In dependent group comparisons, repeated measures analysis of variance was used when parametric test assumptions were met, and the Friedman test was used when parametric test assumptions were not met. The differences between categorical variables were analyzed by Chi-square analysis. All statistical significance tests are conducted in terms of per protocol analysis.

RESULTS

The mean age of the participants was 53.8±10.5 and 52.8±10.8 years for the tele-education and routine-education groups, respectively. Details on the characteristics of the individuals are presented in Table 1. The groups were similar in terms of physical characteristics, duration of diabetes, comorbid diseases-complications, treatment regimen and habits (smoking-alcohol) ($p>0.05$). In terms of MNA scores, only the decrease in the score of routine rehabilitation was significant ($p=0.041$). MNA score did not differ between tele-education and routine rehabilitation groups ($p>0.05$).

MMS-M and MMS-K scores did not differ between the groups in the within- and between-group analysis ($p>0.05$). There was also no significant difference in PAID score between the tele-education and routine rehabilitation groups ($p>0.05$). PAID was not affected by both training programs ($p>0.05$). Individuals' GCEQ scores did not differ within and between groups. Finally, the training program did not affect IPAQ scores ($p>0.05$).

DISCUSSION

This study was planned to investigate the effectiveness of tele-education via mobile phone on exercise goal, physical activity, nutrition, medication habits and diabetes problem status of individuals diagnosed with Type 2 diabetes. The study's results suggested that only tele-education may positively affect nutrition. However, both tele-education and routine education provided similar and insufficient patient outcomes. Future studies may focus on distance education programs with different educational models.

In our study, individuals were educated with general information about diabetes, nutrition therapy, exercise, physical activity, drug therapy, and acute/chronic complications. Interestingly, this education only positively affected the nutrition parameter in the conventional education group. However, it is comprehended that individuals in society have intense demands for nutrition programs, even individually, on diet-related issues (25). We focused on the possibility that nutrition-related education may have been more effective than other education topics. However, no positive effect was achieved in any parameter in the tele-education group. These results suggested that telerehabilitation and conventional education were broadly similar. The fact that the training program did not effectively affect parameters

Table 1: Baseline demographic and clinical data of participants.

	Tele-education (n=15)	Routine education (n=15)	p
Age (years, mean±SD)	53.8±10.5	52.8±10.8	0.838[a]
BMI (kg/m², mean±SD)	29.0±5.7	29.1±4.9	0.838[a]
DM duration (years, mean±SD)	9.0±11.2	10.6±6.6	0.148[a]
Gender (women/men, n)	11/4	7/8	0.264[b]
Comorbid disease (yes/no, n)	11/4	10/5	0.690[b]
Acute complication (yes/no, n)	5/10	5/10	0.068[b]
Chronic complication (yes/no, n)	6/9	4/11	0.700[b]
Treatment (oral/injection/other, n)	11/2/2	10/2/3	0.884[b]
Smoking (yes/no, n)	1/14	4/11	0.330[b]
Alcohol (yes/no, n)	0/15	4/11	0.100[b]

n: The number of participants, **SD:** Standard Deviation, **BMI:** Body Mass Index, **kg:** Kilogram, **m:** Meter, **DM:** Diabetes Mellitus, **a:** Mann-Whitney U Test, **b:** Fisher's Exact Test

Table 2: In-group and between-group difference of the assessments.

		Tele-education (n=15)	Routine education (n=15)	p (between group)
MNA	Before intervention	12.4±1.9	12.8±2.2	0.412[a]
	After intervention	11.8±2.0	12.0±2.1	0.624[a]
	p (within group)	0.166[b]	0.041[b]	
MMS-M	Before intervention	2.1±0.7	2.1±0.8	0.967[a]
	After intervention	1.8±0.7	1.8±0.5	0.870[a]
	p (within group)	0.206[b]	0.059[b]	
MMS-K	Before intervention	2.2±1.0	2.3±0.8	0.775[a]
	After intervention	2.4±0.9	2.3±0.8	0.653[a]
	p (within group)	0.279[b]	1.000[b]	
PAID	Before intervention	20.7±17.0	37.5±33.3	0.325[a]
	After intervention	19.5±16.3	35.6±20.4	0.267[a]
	p (within group)	0.721[b]	0.812[b]	
GCEQ	Before intervention	35.2±12.3	35.6±9.4	0.775[a]
	After intervention	38.2±12.8	36.7±10.4	0.486[a]
	p (within group)	0.153[b]	0.944[b]	
IPAQ	Before intervention	1729.0±2110.6	1549.3±2154.3	0.713[a]
	After intervention	2064.6±2199.0	2405.8±2216.5	0.512[a]
	p (within group)	0.153[b]	0.203[b]	

n: The number of participants, **SD:** Standard Deviation, **MNA:** Mini Nutritional Assessment, **MMS-M:** Modified Morisky Scale-Motivation, **MMS-K:** Modified Morisky Scale-Knowledge, **PAID:** Problem Areas in Diabetes Scale **GCEQ:** Goal Content for Exercise Questionnaire, **IPAQ:** International Physical Activity Questionnaire, **a:** Mann-Whitney U test, **b:** Wilcoxon signed-rank test

other than nutrition led us to interpret that future studies should focus on different training models (26). More specific training of individuals with cognitive behavioral or teleconferencing methods may provide effective clinical outcomes.

In the literature, several telemedicine studies have been conducted on the effectiveness of education in individuals with diabetes. In the current systematic review and meta-analysis, diabetes self-management education with health information technologies was discussed. Although the review results indicated that patients benefited glycemically, it was reported that the degree of benefit decreased after the 12th month. Nevertheless, the success of telehealth education was emphasized (27). In our study, we did not observe any superiority of telemedicine over conventional education. However, we could not obtain an effective result in subjective evaluation parameters even in shorter-term follow-ups. In this review, the emphasis on the lack of success in education even after the 12th month made us think again about the education model's importance (28).

A randomized controlled trial focused on the effectiveness of electronic education on indicators of metabolic control in individuals with diabetes (29). Positive improvements were reported in haemoglobin A1C and cholesterol at the 12-week follow-up. At the same time, the objective parameter emphasis of the study, which reported effective results in terms of patient satisfaction, is essential. In our study, we evaluated with personal tools. In this respect, the effect of our training program on objective indicators may be a hypothesis for future studies.

Another study conducted within the scope of nurse care services reported that the tele-education model for diabetes self-management was effective for long-term behavioural change among people living with chronic disease in rural communities. On the other hand, the training model was reported to be telehealth coaching. However, details were not presented. Our intervention may have been ineffective because the individuals in our study were urban dwellers and may have ignored or taken for granted the educational programs they were already known to have accessed (30). In

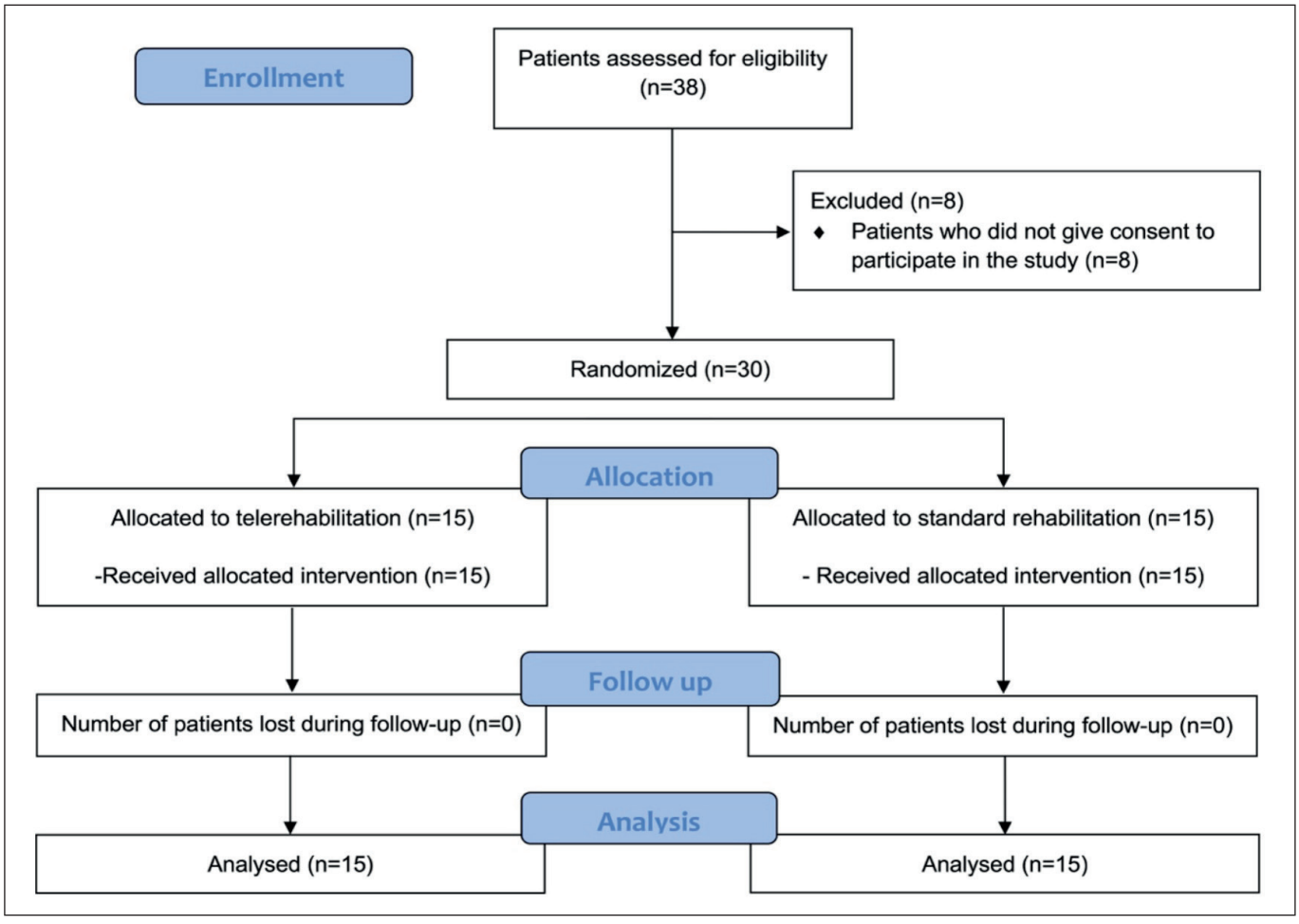

Figure 1. CONSORT flow chart of the study.

a recent pilot study, telehealth provided a significant clinical outcome on secondary outcome measures, including body mass index and blood pressure, compared to conventional interventions (31). However, the small sample size reduces the generalizability of the results, as in our study.

In a randomized controlled study conducted in 2022, it was reported that video tele-education was as effective as face-to-face education methods in compliance with the dietary regimen of diabetic patients in three months (32). Our study found that conventional education was more effective in terms of nutrition. In this study, which is similar to our study regarding the follow-up period, focusing only on a diet may have provided more explicit clinical outcomes. Since the idea of holistic education in our study turned into a workload and boring, inefficient program for patients, the results may be ineffective. Therefore, future studies may create more straightforward education programs.

In another telehealth education intervention study, it was reported that there were clinically significant decreases in mean blood glucose values and weight; satisfaction was high, but applicability was low (33). In our study, we did not address essential parameters for telehealth, such as usability, satisfaction and participation, which can be considered another significant limitation of the study. However, our researchers generally believe that the technological literacy of individuals, even in the middle-aged population, is based on their empirical observations. Nevertheless, objective proof of these results would be valuable for interpreting the results.

Since this study had a randomized controlled design, the groups were homogenous. Therefore, our study provided data at a higher level of evidence than quasi-experimental studies. In addition, the unique aspect of the study is that it includes a multi-disciplinary educational intervention. The results will provide valuable data for more comprehensive randomized controlled studies and meta-analyses because they include clinical implications involving different disciplines.

First, there was no blinding in our study. Future studies should include blinding in the methodology to reduce the risk of bias in the results for evaluators, educators and patients. Second, the effect of education on insulin resistance and other biochemical parameters of diabetes was not addressed. In addition to subjective evaluation criteria, objective parameters may reveal the results of the effectiveness of the training more clearly. Longer-term follow-up of individuals may enable them to make the training program a lifestyle and thus have a more precise effect on the evaluation parameters. For this reason, more studies may focus on long-term follow-up.

The study results suggest that only tele-education has a positive effect on nutrition. However, both tele-education and routine education provided similar and inadequate patient outcomes. Future studies may focus on distance education programs with different educational models.

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None.

Author Contributions

Conceptualization: **Fatih Özden, Serap Tuna,** Methodology: **Serap Tuna, Fatih Özden,** Formal analysis and investigation: **Serap Tuna, Fatih Özden, Özgür Nadiye Karaman,** Writing - original draft preparation: **Serap Tuna, Fatih Özden, Özgür Nadiye Karaman, Cem Şahin, Emine Neşe Yeniçeri,** Writing - review and editing: **Serap Tuna, Fatih Özden, Özgür Nadiye Karaman, Cem Şahin, Emine Neşe Yeniçeri.**

Conflict of Interest

The authors report no conflicts of interest and certify that no funding has been received for this study and/or preparation of this manuscript.

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Ethical Approval

The study was carried out in accordance with the ethical principles and the Helsinki Declaration. The study protocol was approved by the Ethics Committee of Muğla Sıtkı Koçman University (No:24/1, Date: 24.11.2021). Informed consent of the patients was obtained.

Peer Review Process

Extremely peer-reviewed and accepted.

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