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Research Article

The Effect of Fistula Care Education Given with a Mobile Application on Disease Adherence and Self-Care Behaviors in Hemodialysis Patients: A Quasi-Experimental Study

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What is already known on this topic?

- *Vascular access is very important for patients receiving hemodialysis treatment and requires special care. Educating the individual on this issue is also an important element in improving the quality of health care.*
- *Care of AV fistula, which is the most preferred vascular access route, is an effective way to reduce the occurrence of complications and mortality in patients.*
- *The development of self-care behaviors also supports the individual's active participation in disease management and provides early diagnosis of possible complications of AV fistula.*

What this study adds on this topic?

- *It was determined that the mobile application used in AV fistula care education was more effective in increasing the adherence of individuals to the disease than the education given with a booklet.*
- *It was determined that the mobile application used in AV fistula care education was more effective in increasing the fistula care knowledge level of individuals than the education given with a booklet.*
- *It was determined that the mobile application used in AV fistula care education was more effective in improving the self-care behaviors of individuals than the education given with a booklet.*

Abstract

AIM: It was aimed to determine the effect of fistula care education provided through mobile health applications on disease adaptation and self-care behaviors in hemodialysis patients.

METHODS: This is an quasi-experimental study with the pretest–posttest control group design. The research was carried out between June and October 2020 in two private dialysis centers, with the experimental group (n = 30) using the mobile health application in arteriovenous fistula care education and the control group (n = 30) adopting the education guide. "Patient Identification Form," the "Arteriovenous fistula care knowledge form," the "Assessment of self-care behaviors with arteriovenous fistula in hemodialysis," "End-stage renal disease adherence questionnaire," and the "Visual comparison scale" were used to collect the research data. Parametric and nonparametric tests were used to analyze the data. In this study, the STROBE checklist was followed for reporting.

RESULTS: It was observed that hemodialysis patients in the study groups had similar socio-demographic characteristics. According to the pre-education evaluation, there was no statistically significant difference between the groups in terms of commitment to the disease, arteriovenous fistula care knowledge levels, and self-care behaviors ($p > .05$), while a statistically significant difference was found in the same variables between the groups in the first and third months after the education ($p < .05$). According to the evaluation, statistically significant differences were found between the groups in terms of knowledge of arteriovenous fistula care, development of self-care behaviors, and adherence to the disease after the first and third months following the education ($p < .05$).

CONCLUSION: Patients using the mobile health application had higher levels of disease adherence, knowledge of arteriovenous fistula care, and developing self-care behavior compared to the patients using the education booklet.

Keywords: Fistula, mobile health, nursing, self-care, treatment adherence

Introduction

Chronic renal failure is accepted as a primary health problem in the area of public health across the world (Okorie et al., 2018). Hemodialysis, one of its treatments, is the process of filtering the patient's blood and pumping it back to the patient with a special device called a dialysis machine, which works in parallel with the kidney functions. To perform this procedure, vascular access should be opened to the patient's blood vessels via a surgical initiative, and the vascular access should continue to function and be protected. The arteriovenous (AV) fistula is a connection created between an artery and vein by using a variety of methods (Daugirdas et al., 2014). Several factors, such as the properly established vascular access, the adequacy of dialysis, and vascular access care, affect whether patients receiving hemodialysis have a long and good-quality life. Therefore, vascular access is highly crucial for patients and requires

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special care. However, studies show that patients perform arteriovenous fistula self-care at low and moderate levels (İkiz et al., 2021; Iqbal et al., 2018; Sousa et al., 2020). Care of the vascular access route is one of the most effective ways to reduce complications and mortality of patients. Education of the patient on this topic is a factor important to the enhancement of healthcare quality. Patients and their caregivers should be educated about AV fistula care (Davies & Steinwandel, 2023; Iqbal et al., 2018; Sousa et al., 2020).

Besides having a medical aspect such as the stage, the duration, and the mode of treatment of the disease, chronic renal failure has significant effects on the patient's social and economic circumstances and psychological situation. Based on these factors, the patients are likely to have trouble adhering to the disease (Lai et al., 2022; Murali et al., 2019; Sousa et al., 2020; Sugisawa et al., 2023). The patient with high-level adherence to the disease gets eager to meet all knowledge and practice needs for his/her self-care and manages the disease process better (Almasri et al., 2016; Arhuidese et al., 2019; Lemay et al., 2018; Ng et al., 2021). Therefore, ensuring continuity in the education of patients receiving hemodialysis becomes indispensable, and along with the developing technology, distance education instruments become important to education.

Using mobile devices allowing access to educational content regardless of time and space became a need for individuals. Mobile learning through mobile technologies is defined as "learning through ways such as social and content interactions by using personal electronic/mobile devices" (Li et al., 2021). Mobile health (m-health) is defined as a component of e-health. Mobile health applications enable individuals to view their health records and also allow doctors to access these records in a timely manner, and this situation provides patients with the opportunity to get healthcare services outside the normal healthcare settings. Also, m-health applications can offer support on topics such as follow-up and supervision of the patient's health (WHO, 2018). In some studies, compared to routine education programs, the use of mobile technology-based education programs in patient education has been proven to increase the level of knowledge and self-care behaviors that healthcare professionals want patients to access (Liu et al., 2021; Yoo & Suh, 2021; Zhang et al., 2021). In recent years, there was a rapid growth in the number of mobile applications designed in the area of physical activity. Upon the review of the relevant literature, it was discerned that there was no example of an m-health application designed to allow patients receiving hemodialysis to manage their AV fistula-related self-care. Departing from this point, the development of a mobile application focused on education about AV fistula care and promoting the patient's self-care behaviors, and adherence to the disease by raising their levels of knowledge about AV fistula care was planned. It is considered that these technology-based education programs will be more practical and preferable for the patient and will also enhance the patient's adherence to disease and serve as an instrument promoting the patient's self-care. Additionally, it is predicted that these education programs will act as a guide for health professionals in support of the service offered by them.

Hypotheses of the Study

1. Does arteriovenous fistula care education provided with mobile health application have an effect on the fistula self-care level of patients?
2. Does arteriovenous fistula care education provided with mobile health application have an effect on the level of end-stage renal failure adherence of patients?

Methods

Study Design

It was carried out quasi-experimentally in a pretest–posttest control group design between June and October 2020 with 60 hemodialysis patients with AV fistula in two dialysis centers. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement were followed throughout the study protocol (ClinicalTrials.gov ID: NCT04925635).

Sample

The criteria specified for being included in the research were to be aged above 18 years, to be able to have verbal communication, not to be diagnosed with a mental or psychological disease, not to have any hearing or visual disorder, to have an AV fistula, and to have a smartphone. After taking all relevant physical protective measures, the researcher collected the data by visiting the patients who volunteered to participate in the study during the first two sessions of hemodialysis treatment before the education and during the first and third months after the education. Power analysis was applied to the study. To ensure that the study had a statistical power of more than 80%, the study power was calculated as 97% when the size of each study group was calculated as effect size: 1.57, n: 26 and α: 0.05 using G*Power 3.1. On the other hand, considering that certain participants would withdraw from the research, 30 patients were assigned to each study group. Assuming that the patients in the control group would be affected by the intervention considered in this study, patients were recruited from two different dialysis centers as experimental and control to eliminate any bias.

Data Collection Tools

"Patient Identification Form," the "Arteriovenous Fistula Care Knowledge Form", the "Assessment of self-care behaviors with arteriovenous fistula in hemodialysis (ASBHD-AVF)", "End-stage renal disease adherence questionnaire (ESRD-AQ)", and the "Visual Comparison Scale" were used to collect the research data.

Patient Identification Form

The questionnaire has two parts. The first part includes 16 questions about the socio-demographic characteristics of the patients, and the second part includes six questions about the AV fistula-related characteristics of the patients, such as the duration of having AV fistula, any complications, and AV fistula care (Johnson et al., 2016; Sousa et al., 2017, 2020; Zhang et al., 2021).

Arteriovenous Fistula Care Knowledge Form

The semi-structured form prepared by the researcher contains 13 questions about patients' levels of knowledge about AV fistula care. The questions were prepared in parallel with the AV

fistula care education booklet and m-health application content to be used before and after the education, and the opinions of 15 experts and stakeholders were obtained. Experts and stakeholders were asked to evaluate the questions with the criteria of "very good", "acceptable," and "poor" levels of appropriateness in terms of conciseness and clarity of language, clarity and clarity of questions, parallelism with the educational content, visualization in an appropriate format and integrity between questions. After the evaluation, 82.4% responded "very good" and 17.6% "acceptable." As per the scoring of a question in the form, point 0 shows that the respondent has no knowledge whereas point 1 indicates that the respondent has knowledge. The total score a participant will receive from this form is 0 or 13 points. The higher the score, the higher the level of knowledge of the individual (Hudson et al., 2020; Kutlu & Ok, 2020).

Assessment of Self-care Behaviors with Arteriovenous Fistula in Hemodialysis

The scale was developed in 2015 and consists of 16 items (Sousa et al., 2015). It is one point indicating that the participant has never developed the relevant self-care behavior and five points indicating that the participant always has the relevant self-care behavior. A minimum of 16 and a maximum of 80 points can be obtained from the scale. The higher a participant's score on the overall scale, the more effective self-care behaviors the participant is considered to have. The validity and reliability study of the scale in Turkish was conducted in 2020 and Cronbach's α coefficient was found to be 0.91 (İkiz et al., 2021). In the current study, the Cronbach's α value of the scale was calculated as 0.86.

End-stage Renal Disease Adherence Questionnaire

The questionnaire developed in 2010 consists of five sections and 46 items (Kim et al., 2010). One section includes five items related to the patient's end-stage renal disease and renal replacement therapy, and the other sections including subdimensions are hemodialysis continuity (14 items—600 points), medications (nine items—200 points), fluid restrictions (10 items—200 points), and compliance with dietary recommendations (eight items—200 points). A minimum score of 0 and a maximum score of 1200 points can be obtained from the questionnaire. The Turkish adaptation study of the questionnaire was conducted in 2019 and correlation coefficients (*r*) were found between 0.48 and 0.80 (Kutlu & Ok, 2020). In this study, the range of correlation coefficients (*r*) is 0.68–0.81. A high score in the questionnaire indicates a high level of agreement.

Visual Comparison Scale

The scale was utilized to evaluate each patient's satisfaction with the AV fistula education. The patients were asked to rate the AV fistula education from 1 to 10 points. While 1 point indicated the lowest level of satisfaction, 10 points showed the highest level of satisfaction (Sung & Wu, 2018).

Procedures

The study was performed in two stages (Figure 1).

Stage 1: *Analysis phase*: the researcher prepared the content of the m-health application and education booklet to be used in AV fistula care based on the literature. In the control group, the education booklet, which is the traditional education material frequently used in hemodialysis units, was preferred. The platforms to be used for the development of the mobile application and existing education programs were scanned and examined. It was decided to use the most widely used ADDIE (Analysis, Designing, Development, Implementation and Evaluation) Model in the mobile application software process. The researcher received certified software programming education for the platform planned to be used. *Designing and development phase*: the m-health application AV fistula care education program is approximately 15 minutes. There are eight buttons in the content of the m-health education application for individuals with fistula. The first button contains the kidneys, the second button contains hemodialysis, the fourth button contains life with AV fistula, the fifth button contains one page of theoretical information with pictures about AV fistula complications, the seventh button contains contact information of hospitals, and the eighth button contains bibliography. There are two sub-buttons in the third button, the first sub-button contains one page theoretical information about AV fistula with pictures and the second sub-button contains a video (3D animation with sound, 4 minutes) about AV fistula. Switching between buttons is free. There is no exam in the application. The software is made on the Android Operating System. The software of the m-health application used in AV fistula care education was made by the researcher. The name of the application was determined "Fistul-M". *Implementation and evaluation phase*: nephrologist (2), academic nurse (2) in Internal Medicine Nursing, academic nurse (4) in Fundamentals of Nursing (4), clinician nurse (4), patient with AV fistula (2), and the patient's relatives (1), expert and stakeholder opinions were obtained from a total of 15 people. During the development of the m-health application, in terms of content, readability, and usability, Computer Engineering Software Department (1), Computer Engineering Hardware Department (2), Computer Engineering Theoretical Fundamentals Department (3), academic nurse (3), clinician nurse (3), the patient with AV fistula (2) and the patient's relative (1) were interviewed, and expert and stakeholder opinions were obtained from a total of 15 people. Experts were asked to evaluate the mobile application according to the evaluation form. In the form, experts and stakeholders were asked to evaluate the mobile application on the language is clear, concise and comprehensible, the visual content is appropriate and sufficient, there is a title page with attention-grabbing and short information, the instruction page is descriptive and clear, the buttons and visual format in the software provide integrity on all pages, and visual and auditory elements are included in addition to text in presenting information. They were asked to examine the technical features such as providing detailed information according to the user's request, choosing the appropriate colors used in the application and ease of use, providing exit with user control, installing the software and running it in any environment with "very good", "acceptable" and "poor" levels of suitability. After the evaluation, 82.7% responded "very good" and 17.3% "acceptable."

Stage 2 (Implementation and Data Collection Stage): The patients were asked to read and sign the "Informed Consent Form" before the education and the researcher completed the "Patient Identification Form" for each patient. Next, the patients were evaluated with the "Arteriovenous Fistula Care

STAGE 1

- Analysis
- Modelling
- Software
- Expert and stakeholder opinion

(m-health application and education booklet)

STAGE 2

Time	Experimental Group	Control Group
Pre-education	Informed Consent Form, Patient Identification Form, Assessment of Self-Care Behaviors with Arteriovenous Fistula in Hemodialysis, End-Stage Renal Disease Adherence Questionnaire, Arteriovenous Fistula Care Knowledge Form (Pre-educational section).	Informed Consent Form, Patient Identification Form, Assessment of Self-Care Behaviors with Arteriovenous Fistula in Hemodialysis, End-Stage Renal Disease Adherence Questionnaire, Arteriovenous Fistula Care Knowledge Form (Pre-educational section).
	AVF Care Training with Mobile Application	AVF Care Training with Education Booklet
1st month after education	Assessment of Self-Care Behaviors with Arteriovenous Fistula in Hemodialysis, End-Stage Renal Disease Adherence Questionnaire, Arteriovenous Fistula Care Knowledge Form (Post-educational section).	Assessment of Self-Care Behaviors with Arteriovenous Fistula in Hemodialysis, End-Stage Renal Disease Adherence Questionnaire, Arteriovenous Fistula Care Knowledge Form (Post-educational section).
3rd month after education	Assessment of Self-Care Behaviors with Arteriovenous Fistula in Hemodialysis, End-Stage Renal Disease Adherence Questionnaire, Arteriovenous Fistula Care Knowledge Form (Post-educational section).	Assessment of Self-Care Behaviors with Arteriovenous Fistula in Hemodialysis, End-Stage Renal Disease Adherence Questionnaire, Arteriovenous Fistula Care Knowledge Form (Post-educational section).

Figure 1.
Stages of the Study.

Knowledge Form" (the part applied before the education), the "ASBHD-AVF", and "ESRD-AQ." The researcher downloaded the m-health application related to AV fistula care to the smartphones of the patients in the experimental group free of charge and introduced the application to these patients. Subsequently, the researcher provided the patients in the control group with AV fistula care education by using the education booklet whilst the patients in the experimental group took AV fistula care education offered by the researcher with the m-health application. The patients were visited every week, and they were asked to use the education booklet and the "Fistul-M" application at least once a week and were observed. The researcher evaluated the results of the education with data collected from patients after the first and third months following the education via the "Arteriovenous Fistula Care Knowledge Form" (the part applied after the education), the "ASBHD-AVF," and the "ESRD-AQ."

Statistical Analysis

The study data were analyzed with the Statistical Package for Social Sciences version 25.0 software (IBM Corp.; Armonk, NY, USA), and statistical significance was determined if the *p*-value was below .05 ($p < .05$). The normality of the data was examined with the Kolmogorov–Smirnov normality test. Nonparametric data were analyzed with Skewness and kurtosis values (+1 to −1). The data were normally distributed and independent sample *t*-test and Pearson chi-square test were used to analyze the data. Descriptive statistics (number, percentage, arithmetic mean, and standard deviation) were used to evaluate the

research data. In addition, repeated measures analysis of variance (ANOVA) was used in the study and Bonferroni test was used to determine the difference.

Ethical Considerations

This study was approved by the İstanbul Medipol University Non-Interventional Clinical Trials Ethics Committee (Approval no: 1125, Date: December 25, 2019). In the study based on the Declaration of Helsinki, each participant was informed verbally and in writing and their signatures were obtained. The clinical trial registration number is NCT04925635.

Results

Statistical analysis revealed significant differences between the two groups in terms of duration of hemodialysis treatment, duration of AV fistula, problems related to AV fistula and obtaining information about AV fistula care. In addition, there were significant differences between the groups in terms of "sleep difficulties" and "limitation in social life" under AV fistula-related problems, as well as "thrombosis", "aneurysm," and "infection" under AV fistula-related problems ($p < .05$) (Table 1).

The findings regarding the knowledge levels of patients regarding AV fistula care are shown in Table 2.

According to the pre-test evaluation of the AV fistula care knowledge levels of the patients in the experimental and control groups before the education, it was determined that there was no statistically significant difference between the two groups ($p > .05$). On the other hand, in the post-test evaluation made after the first and third months following the AV fistula care education, it was found that the patients in the experimental group obtained higher mean knowledge scores than those in the control group and these differences between the two groups were statistically significant ($p < .05$). The increase in the AV fistula care knowledge level of the control group in the first month post-education evaluation score compared to the pre-education evaluation score is significant. The decrease in the third month evaluation score is significant compared to the first month evaluation score after the education ($p < .05$). The increase in the AV fistula care knowledge level of the experimental group in the first month and third month evaluation score after the education is significant compared to the pre-education evaluation score. The decrease in the third month evaluation score is significant compared to the first month evaluation score after the education ($p < .05$) (Table 2).

Comparison of the total scores of the patients' ASBHD-AVF is shown in Table 3.

According to the comparison of the mean ASBHD-AVF scores of the patients in the groups before the education, there was no statistically significant difference ($p > .05$). However, in the post-test evaluation performed after the first and third months following the initial AV fistula care education, it was found that the patients in the experimental group had higher mean ASBHD-AVF scores, and these differences between the two groups were statistically significant ($p < .05$). The increase in the total scores of ASBHD-AVF in the control group in the first month and third month evaluation scores after the education compared to the pre-education value is significant. The decrease in the third month value is significant compared to the first month evaluation score after the education ($p < .05$). The increase in the total scores of ASBHD-AVF in the experimental group in the first month and third month evaluation scores after the education compared to the pre-education value is significant. The increase in the third month value is significant compared to the first month evaluation score after the education ($p < .05$) (Table 3).

The comparison of the ESRD-AQ total scores of the individuals included in the study according to the measurement months is given in Table 4.

Within the framework of the comparison of the pre-education ESRD-AQ scores of the patients in the experimental and control groups, it was determined that there was no statistically significant difference between the experimental and control groups ($p > .05$). On the other hand, in the post-test assessment performed after the first and third months following the AV fistula care education, it was observed that the patients in the experimental group obtained higher mean ESRD-AQ scores than those in the control group, and these differences between the two groups were statistically significant ($p < .05$). Compared to the pre-education evaluation scores of the control group, the increase in the first month and third month evaluation scores after the education is significant. The decrease in the third month value is significant compared to the first month evaluation score after the ESRD-AQ education. The increase in the first month and third month post-education evaluation scores of the experimental group is significant compared to the pre-education evaluation scores. The increase in the third month value is significant compared to the 1st month evaluation score after ESRD-AQ education ($p < .05$) (Table 4).

The total score comparison of the ESRD-AQ subscales of the patients is shown in Table 5.

When the mean ESRD-AQ subscale scores of the patients in the experimental and control groups were compared before the education, it was found that there was no statistically significant difference between the experimental and control groups ($p > .05$). However, in the post-test evaluation performed after the first and third months following the AV fistula care education, it was determined that the patients in the experimental group obtained higher mean scores on the ESRD-AQ adaptation subscales than the patients in the control group. This difference between the two groups was statistically significant ($p < .05$). In the control group, the increase in the first month and third month values after the education is significant compared to the pre-education evaluation score of the sub-dimensions of adherence to diet, fluid restriction and medication use of the ESRD-AQ. The decrease in the third month value after the education compared to the first month value after the education was significant ($p < .05$). In the hemodialysis treatment adherence sub-dimension, it was found that the increase in the first month and third month values after the education compared

Table 1.
Distribution of Disease and AV Fistula Characteristics of Individuals (n = 60)

Features	Control (n=30)	Experimental (n=30)	Total	*p**
Kidney disease diagnosis time Mean ± SD	9.99 ± 5.92	8.03 ± 2.92	9.01 ± 4.74	.113
	n (%)	*n* (%)	*n* (%)	*p***
Chronic disease				
Yes	17(56.7)	13(43.3)	30(50.0)	.219
No	13(43.3)	17(56.7)	30(50.0)	
Hemodialysis treatment time				
1–3 years	7(23.3)	8(26.7)	15(25.0)	
4–7 years	7(23.3)	16(53.3)	23(38.3)	.017
7 years or more	16(53.3)	6(20.0)	22(36.7)	
Frequency of hemodialysis per week				
2 times a week	5(16.7)	4(13.3)	9(15.0)	.500
3 times a week	25(83.3)	26(86.7)	51(85.0)	
AV fistula duration				
1–3 years	10(33.3)	18(60.0)	28(46.7)	
4–7 years	4(13.3)	6(20.0)	10(16.7)	.027
7 years and more	16(53.3)	6(20.0)	22(36.7)	
Having trouble with the AV fistula				
Yes	9(30.0)	1(3.3)	10(16.7)	.006
No	21(70)	29(96.7)	50(83.3)	
Problems with AV fistula* **				
Difficulty in sleeping	9(30.0)	26(86.7)	35(58.3)	.000
Being restricted in social life	10(33.3)	2(6.7)	12(20.0)	.010
Concern about damage to the fistula	15(50.0)	17(56.7)	32(53.3)	.605
Do not be disturbed by the image	3(10.0)	3(10.0)	6(10.0)	.527
Difficulty while eating	4(13.3)	2(6.7)	6(10.0)	.389
Difficulty taking a bath	5(16.7)	3(10.0)	8(13.3)	.448
AV fistula care information				
Yes	24(80.0)	30(100.0)	54(90.0)	.012
No	6(20.0)	–	6(10.0)	
AV fistula complication				
No	8(26.7)	5(16.7)	13(21.7)	.299
I'm not sure	9(30.0)	6(20.0)	15(25.0)	
Yes	13(43.3)	19(63.3)	32(53.3)	
AV fistula complication type* **				
Thrombosis	10(33.3)	4(13.3)	14(23.3)	.039
Stenosis	4(13.3)	–	4(6.7)	.369
Aneurysm	2(6.7)	14(46.7)	16(26.7)	.001
Ischemia	2(6.7)	–	2(3.3)	.150
Infection	1(3.3)	13(43.3)	14(23.3)	.002
Hematoma/hemorrhage	11(36.7)	4(13.3)	15(25.0)	.075

Note: *Independent groups *t*-test.
**Pearson chi-square test ($p < .05$).
***More than one option was marked and percentages were calculated over "*n*".

Table 2.
Comparison of the Knowledge Levels of Individuals about AV Fistula Care (n = 60)

	Control (*n* = 30)	Experimental (*n* = 30)		
	Mean ± SD	**Mean ± SD**	*t*[a]	*p*
Before education	6.13 ± 2.51	6.36 ± 2.05	−0.393	.696
First month after education	7.90 ± 2.85	12.46 ± 1.04	−8.225	.000
Third month after education	7.23 ± 2.89	11.36 ± 1.42	−7.012	.000
F[b]	5.377	127.898		
p	.026	.000		
Bonferroni	2 > 1.3	1 < 2.3; 2 > 3		

Note: [a]Independent groups *t*-test.
[b]Repeat measurements ANOVA test ($p < .05$).

to the pre-education evaluation score did not show statistical significance ($p > .05$). The increase in the first month and third month values of the experimental group after the education is significant compared to the pre-education evaluation score of the ESRD-AQ adherence to diet, fluid restriction, and medication use sub-dimensions of the experimental group. The increase in the third month value after education compared to the first month value after education is significant ($p < .05$). In the hemodialysis treatment adherence sub-dimension, the increase in the first month and third month values after the education compared to the pre-education evaluation score did not show statistical significance ($p > .05$) (Table 5).

Comparison of the findings regarding the total Visual Comparison Scale scores of the individuals included in the study is given in Table 6.

Upon the evaluation of participants patients' levels of satisfaction with the AV fistula care education, it was discerned that

Table 3.
Comparison of the Total Scores of the Self-care Behaviors Evaluation Scale for Arteriovenous Fistula in Hemodialysis Patients (n = 60)

	Control (*n* = 30)	Experimental (*n* = 30)		
	Mean ± SD	**Mean ± SD**	*t*[a]	*p*
Before education	41.76 ± 7.91	43.60 ± 7.15	−0.942	.350
First month after education	52.60 ± 6.39	72.56 ± 2.01	−16.318	.000
Third month after education	48.86 ± 7.00	73.90 ± 3.36	−17.650	.000
F[b]	71.059	522.290		
p	.000	.000		
Bonferroni	1 < 2.3; 2 > 3	1 < 2.3; 2 < 3		

Note: [a]Independent groups *t*-test.
[b]Repeat measurements ANOVA test ($p < .05$).

Table 4.
Comparison of Individuals' Total Scores of ESRD-AQ (n = 60)

	Control (*n* = 30)	Experimental (*n* = 30)		
	Mean ± SD	**Mean ± SD**	*t*[a]	*p*
Before education	905.00 ± 66.43	946.66 ± 122.60	−1.637	.109
First month after education	1065.00 ± 58.94	1136.66 ± 61.49	−4.608	.000
Third month after education	1016.66 ± 88.65	1156.66 ± 55.29	−7.339	.000
F[b]	71.059	114.578		
p	.000	.000		
Bonferroni	1 < 2.3; 2 < 3	1 < 2.3; 2 < 3		

Note: [a]Independent groups *t*-test.
[b]Repeat measurements ANOVA test ($p < .05$).

the patients in the experimental group had a higher mean of satisfaction scores than those in the control group and this difference was statically significant ($p < .05$) (Table 6).

Discussion

Education has a crucial place in sustaining life with the AV fistula and enhancing adherence to AV fistula care. Fistula-M, the m-health application developed within the scope of this study, was found to be a more effective tool than written educational materials in improving AV fistula patients' self-care behaviors and increasing their adherence to the disease.

Upon the review of studies conducted on patients receiving hemodialysis, it was discerned that the finding of the current study about the disease duration after the diagnosis of the renal disease and the state of having another chronic disease besides chronic renal failure was similar to those obtained in the studies in the relevant literature (Glyde et al., 2019; Jadoul et al., 2019; Karavetian et al., 2015; Ozen et al., 2019).

When the characteristics of the participant patients related to AV fistula were analyzed, it was found that 46.7% had AV fistula for 1–3 years. Similar to the findings of the current study, a research study found that participants used AV fistula for an average of 4–10 years (Sousa et al., 2017). In this study, 83.3% of the participating patients had a problem with AV fistula, 90% had received information about AV fistula care, and 53.3% had at least one complication. In this context, available research shows that approximately 30% of hospitalizations are due to venipuncture and its complications (İkiz et al., 2021; Iqbal et al., 2018; Sousa et al., 2020). Important complications of hemodialysis fistula include lymphedema, infection, aneurysm, stenosis, congestive heart failure, steal syndrome, ischemic neuropathy, and thrombosis (Aljuaid et al., 2020). In the present study, it was found that there were statistically significant differences between the experimental and control groups in terms of the duration of hemodialysis treatment and the duration of AV fistula use in parallel with this, the status of having problems with

Table 5.
Comparison of the Total Scores of the ESRD-AQ Sub-dimensions of the Individuals (n = 60)

ESRD-AQ Sub-Dimensions	Control (*n* = 30)	Experimental (*n* = 30)		
	Mean ± SD	Mean ± SD	*t*[a]	*p*
Adherence to diet recommendations				
Before education	106.66 ± 31.44	118.33 ± 38.24	−1.291	.202
First month after education	138.33 ± 31.30	165.00 ± 32.56	−3.234	.002
Third month after education	128.33 ± 33.94	176.66 ± 31.44	−5.722	.000
F[b]	20.812	45.839		
p	.000	.000		
Bonferroni	1 < 2.3; 2 > 3	1 < 2.3; 2 < 3		
Adherence to fluid restrictions				
Before education	113.33 ± 34.57	125.00 ± 48.69	−1.070	.290
First month after education	151.66 ± 30.74	178.33 ± 31.30	−3.329	.002
Third month after education	136.66 ± 39.24	183.33 ± 27.33	−5.344	.000
F[b]	18.942	56.353		
p	.000	.000		
Bonferroni	1 < 2.3; 2 > 3	1 < 2.3		
Adherence to medications				
Before education	151.66 ± 30.74	166.66 ± 27.33	−1.997	.051
First month after education	183.33 ± 27.33	198.33 ± 9.12	−2.851	.007
Third month after education	173.33 ± 34.07	200.00 ± 0.00	−4.287	.000
F[b]	23.651	44.373		
p	.000	.000		
Bonferroni	1 < 2.3; 2> 3	1 < 2.3		
Adherence to hemodialysis attendance				
Before education	533.33 ± 67.70	536.66 ± 76.20	−0.179	.858
First month after education	591.66 ± 32.38	595.00 ± 27.38	−0.430	.668
Third month after education	578.33 ± 46.30	596.66 ± 18.25	−2.018	.051
F[b]	20.812	21.029		
p	.000	.000		
Bonferroni	1 < 2.3	1 < 2.3		

Note: [a]Independent groups *t*-test.
[b]Repeat measurements ANOVA test.

Table 6.
Comparison of Individuals' Satisfaction with Arteriovenous Fistula Care Education (n = 60)

	Control (*n* = 30)	Experimental (*n* = 30)		
	Mean ± SD	Mean ± SD	*t*[a]	*p*
Visual comparison scale	8.80 ± 0.92	9.80 ± 0.40	−5.421	.000

Note: [a]Independent Groups *t*-test ($p < .05$).

AV fistula (sleep difficulties and restriction in social life), the status of obtaining information about AV fistula care, and the status of developing complications (thrombosis, aneurysm, and infection) ($p < .05$).

In the current study, while there was no statistically significant difference in the patients' knowledge assessment scores about AV fistula care between the groups before the education, significant differences were found between the two groups in the first and third months after the education. These findings showed that the patients using the m-health application had significantly higher increases in knowledge levels than those using only the education booklet ($p < .05$). It is put forward that, to prevent complications to be developed in patients, AV fistula care education should be regularly given to patients with an approach allowing patients to "see, hear, and feel" the arteriovenous access (Ng et al., 2021). It is also suggested that integrating AV fistula self-care into daily self-care may prevent various complications associated with AV fistula (Micha et al., 2017).

In the current research, as per the variable of the study group, there was no statistically significant difference in participant patients' mean pretest ASBHD-AVF scores before education ($p > .05$), whereas there were statistically significant differences in participant patients' mean post-test. In the current research, as per the variable of the study group, there was no statistically significant difference in participant patients' mean pretest ASBHD-AVF scores before education scores after the first and third months following education ($p < .05$). The studies performed on this topic also indicate that the nursing interventions increased self-care and self-management skills in patients with AV fistula and developed these patients' AV fistula-related knowledge, skills, and attitudes (İkiz et al., 2021; Sousa et al., 2017, 2020).

In the current research, as per the variable of the study group, there was no statistically significant difference in patients' mean pretest ESRD-AQ scores before education ($p > .05$). There were statistically significant differences in patients' mean post-test ESRD-AQ scores after the first and third months following education ($p < .05$). Moreover, upon the comparison of patients' mean ESRD-AQ sub-scale scores as per the variable of the study group, there was no statistically significant difference in mean sub-scale scores before education ($p > .05$). There were statistically significant differences in mean scores obtained from the sub-scales of adherence to diet recommendations, fluid restrictions, and medications after the first and third months following education ($p < .05$).

These statistically significant differences indicate that the education provided with an m-health application was more effective than the education offered by using the education booklet. It is asserted that approximately 45% of the patients having hemodialysis treatment had medium-level or poor adherence to treatment (Naalweh et al., 2017). A study showed that compliance with HD treatment was high, but compliance with fluid and dietary restrictions was low (Arjunan et al., 2018). It is known that quality of life and blood values (especially electrolytes) are improved in hemodialysis patients with nutritional education (Naseri-Salahshour et al., 2020).

As the results of the analysis of in-group follow-ups in the study show, education and follow-up at regular intervals are important. It was argued that HD patients with arteriovenous fistula and their families should be given planned education on self-care and should be repeated at regular intervals (Sousa et al., 2017). It is noted that most complications associated with the use of the arteriovenous fistula access site can be prevented by adopting a specific daily self-care plan (İkiz et al., 2021; Sousa et al., 2017; Sousa et al., 2019). So continuous education is important.

There is a statistically significant difference in the scores of patients' evaluation of AV fistula care education with the visual comparison scale according to the groups ($p < .05$). In the literature review, similar to our study findings, it has been shown that the combination of visual and auditory materials such as m-health applications in patient education is effective, and it is also an effective tool in increasing the patient satisfaction rate at a positive level (Aljuaid et al., 2020; Arjunan et al., 2018; Guo et al., 2017).

Study Limitations

The limitations of the study are that the application only works on the Android Operating System, there is no tracking feature and the software language is only Turkish.

Conclusions and Recommendations

Vascular access care and adherence to disease are of great importance to patients having hemodialysis treatment. It was found that the m-health application was more effective in enhancing patients' adherence to the disease, increasing their AV fistula care knowledge levels, and developing their self-care behaviors than the education booklet in the context of AV fistula care education. It is recommended to integrate the mobile health application into the AV fistula care patient education programs given in routine clinics, to repeat these education programs at regular intervals, to make the software of the mobile application compatible with all operating systems, to update and develop the mobile application by adding sections where individuals with AV fistula can receive counseling by uploading photos and videos, to repeat quantitative and qualitative studies on psychosocial problems experienced by individuals with AV fistula in a larger sample group. In addition, it is recommended that education and counseling services for the solution of all kinds of physical, social and psychological problems experienced by individuals with AV fistula and for their adaptation should be provided through the mobile application, and experimental studies should be conducted in different groups, with a larger sample and longer duration in order to determine the effect of the mobile application on individuals' self-care and adherence to the disease.

Availability of Data and Materials: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: This study was approved by the İstanbul Medipol University Non-Interventional Clinical Trials Ethics Committee (Approval no: 1125, Date: December 25, 2019).

Informed Consent: In the study conducted according to the Declaration of Helsinki, all patients were informed verbally and in writing and signed documents were obtained. Patients had the right to withdraw their participation at any time without further explanation.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – C.O.; Design – C.O., M.S.; Supervision – M.S.; Resources – C.O., M.S.; Materials – C.O., M.S.; Data Collection and/or Processing – C.O.; Analysis and/or Interpretation – C.O., M.S.; Literature Search – C.O., M.S.; Writing Manuscript – C.O., M.S.; Critical Review – M.S.

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Expert Opinion Evaluation Form

Dear.....,

I am a PhD student at the University of Health Sciences, Institute of Health Sciences, Nursing Program. Within the scope of my doctoral thesis, under the guidance of my advisor, I plan to conduct a study titled "The Effect of Fistula Care Education Provided with Mobile Health Application on Adherence to Disease and Self-Care Behaviors in Hemodialysis Patients".

The mobile application template for arteriovenous fistula care education, which is presented in the appendix, has been prepared for the education of individuals with kidney disease for arteriovenous fistula care within the scope of the thesis.

You are expected to indicate your assessment of whether the items listed in the table below and the mobile application are suitable for the purpose of the research by using an "X" sign in one of the suitability levels options opposite the statement.

	Arteriovenous Fistula Care Education Software (Mobile Application)				
		Compliance Level			
	Criteria	**Very good**	**Acceptable**	**Weak**	**Description / Recommendations**
1.	Language should be clear, concise, and comprehensible				
2.	Appropriate and sufficient visual content				
3.	A title page that is attention-grabbing and contains short information				
4.	Directive page is descriptive and clear				
5.	The buttons and visual format in the software provide integrity on all pages				
6.	Including visual elements as well as text in the presentation of information				
7.	Including auditory elements as well as text in the presentation of information				
8.	Providing detailed information according to user request				
9.	Appropriate selection of colors used in the application				
10.	Ease of use of the application				
11.	Providing exit with user control				
12.	Technical features such as installing the software and running it in any environment				
Date / Signature					

Thank you for your valuable feedback.