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The Impact of A Self-Education Mobile Application (Hd-Sema) on Quality of Life Among Hemodialysis Patients

Gina Nurdina[1], Wina Yulia Nazwa Hidayat[2], dan Ratna Yuliyawati[2]

[1]Departement of Nursing, STIKep PPNI Jawa Barat, Indonesia
[2]Bachelor Nursing Study Program, STIKep PPNI Jawa Barat, Indonesia
*Corresponding email**: ghina.nurdina@gmail.com**

A B S T R A C T

Introduction: Quality of life is an essential aspect in assessing the management of hemodialysis (HD) patients' overall well-being. Therefore, researchers developed a mobile application called HD-SEMA (Hemodialysis Self Education Management). HD-SEMA application is designed to provide health information and guidance regarding self-management in HD patients. **Objective:** Researchers are interested in conducting research aimed at finding out the influence of the HD-SEMA mobile application on the quality of life of HD patients. **Methods:** A quasi-experimental two-group pretest-posttest design with repeated measures was employed. The study was conducted in West Java with 60 participants (30 intervention, 30 control). The intervention group used the HD-SEMA application for four weeks, with sessions conducted twice per week (30–40 minutes each). The control group received standard hospital education. Quality of life was measured using the KDQoL-SF36. **Results:** Description of Quality of Live in the pre-test intervention group with a mean value of 45.81 and SD 9.33 and post-test 50.03 and SD 8.24. The quality of Live identification results in the intervention group is between the average score of the pre-test and post-test with a value of t=-9.16 and a significance value of 0.000. the mean difference value is 4.22, and the significance value is 0.000. This value shows the difference between the average self-management score of the intervention group and the control group. **Conclusions:** IT-based intervention is the proper intervention to increase knowledge in self-management in CKD patients so that the patient's quality of life also improves. HD-SEMA also helps patients assess their progress over time by tracking changes in health parameters and disease progression. This evaluation allows patients to evaluate the effectiveness of their treatment and make necessary changes.

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1. INTRODUCTION

Hemodialysis (HD) is a routine and safe therapeutic option to replace some kidney function, reduce morbidity, and improve the quality of life in patients with terminal chronic kidney disease or CKD (Armiyati et al., 2021). Based on WHO data, in 2021, more than 216 countries recorded 165,158,285 confirmed cases and 3,425,017 deaths. The latest data according to the 7th Report of the Indonesian Renal Registry, every year, Indonesia experiences an increase in patients undergoing hemodialysis; it is estimated that there are 17,193 new patients and 11,689 active patients with a death rate reaching 2,221 in 2019 (*Laporan Riskesdas 2018 Nasional*, n.d.). Every year, this figure will continue to increase.

Hemodialysis patients require ongoing treatment throughout their lives, such as medication, diet, fluid restrictions, emotional management, activities, and social life, all of which must be adjusted to the condition of their disease. Due to the high mortality rate in hemodialysis patients, treatment is aimed at reducing the mortality rate, reducing the incidence of comorbidities, and improving health-related quality of life. Quality of life is an individual's perception of their life position in the context of culture, value systems, and its relationship to life goals, expectations, standards, and other related matters. Quality of life is a primary need for hemodialysis patients because pathophysiologically, the disease they are experiencing is terminal, so achieving the most optimal quality of life in a condition of helplessness is a priority (Akram et al., 2023; Yonata et al., 2022)

Quality of life is an essential aspect in assessing the management of hemodialysis patients' overall well-being. It is influenced by symptoms/problems, effects of kidney disease, burden of kidney disease, physical health components, and mental health components. Dialysis patients often experience a decrease in quality of life due to chronic physical symptoms, emotional stress, medication, comorbidities, and limitations in daily life activities(Anjum et al., 2024). Poor quality of life itself also increases complications such as depression and malnutrition and even increases mortality rates. The results showed that the quality of life in hemodialysis patients was lower than in regular people, with an average score of 49.83 ± 17.56. these patients need to live a happy life. Therefore, interventions are required in order to improve their quality of life(Qu & Shen, 2023).

Based on the results of research conducted by Lee et al., health education, continuity of care, and increased knowledge of self-management have played an essential role in improving quality of life, reducing health service costs, and improving the treatment process(Lee et al., 2016). Park et al. studied 89 patients with acute kidney injury. The results show that modern nursing methods and self-management training facilitate the recovery process and improve quality of life with a p-value of 0.001(Park & Kim, 2019). In general, continuity of care and self-management have become new therapeutic strategies to increase the self-confidence of hemodialysis patients

According to Barlow et al., self-management refers to an individual's ability to holistically manage illness and lifestyle changes inherent in living with a chronic illness. Key components of self-management include information, drug management, symptom management, management of psychological consequences, lifestyle, social support, and communication (Barlow et al., 2002). Meanwhile, self-management in hemodialysis patients includes commitment to the hemodialysis schedule, use of medication, regulation of diet and fluid consumption, as well as emotional control(Ma et al., 2022). Hemodialysis patients' self-management abilities increase and delay disease progression by providing self-management education, which includes education on diet,

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fluid restriction, and management. It has been shown that an intelligent team formed by professionals can improve patients' self-management abilities and even delay disease progression. Therefore, the long-term management of end-stage renal disease needs to explore intelligent software that can dynamically monitor and develop educational programs that can be used at any time (Park & Kim, 2019).

The era of the Industrial Revolution 4.0 is marked by technological advances such as Artificial Intelligence (AI), robotics, and the Internet of Things (IoT), which have changed the old order in various aspects of life, including the health sector. In fact, the number of smartphone users in Indonesia is estimated to reach more than 190 million by 2023. Several studies have used innovative technology, such as smartphones and mobile applications, as additional methods for treating hemodialysis patients. One of them is research by Marinho (2013), which found that as many as 59.3% of hemodialysis patients believe that using applications can help them manage their disease and increase treatment compliance. Other research shows that smartphones have improved communication and routine monitoring between health professionals and patients, as well as compliance with medication use and lifestyle changes (Marinho et al., 2023).

Other studies have demonstrated that mHealth applications for home-based self-management among hemodialysis patients can significantly improve self-care behavior ($p = 0.002$) and reduce clinical indicators such as blood pressure ($p = 0.001$) (Sangrawee Maneesri et al., 2022). Similarly, mobile-based self-management education has shown efficacy in enhancing quality of life in patients with chronic conditions, such as Parkinson's disease (Khachian et al., 2023). Building on this evidence, the researchers developed HD-SEMA (Hemodialysis Self-Education Management Application), a mobile application specifically tailored to address the multifaceted self-management needs of patients undergoing hemodialysis.

In response to these findings and the lack of localized digital interventions for hemodialysis patients in Indonesia, the researchers developed a mobile application named HD-SEMA (Hemodialysis Self-Education Management). Unlike existing mHealth applications that often focus on singular aspects such as medication adherence or fluid tracking, HD-SEMA is a multi-featured, integrated platform specifically designed for hemodialysis patients. It offers six comprehensive modules: (1) self-management education, (2) fluid restriction strategies, (3) personalized nutritional management, (4) medication tracking, (5) monitoring of hemodialysis adequacy, and (6) emotional and stress management. In addition, HD-SEMA incorporates interactive elements such as relaxation training videos, daily reminders, and feedback loops based on user-reported data, aiming to enhance patient engagement and adherence.

The app was developed using a co-design approach, actively involving nephrologists, dialysis nurses, and hemodialysis patients at every stage—from content planning to usability testing. During the development process, the research team also conducted focus group discussions (FGDs) to identify their needs, preferences, and challenges in self-management. This collaborative approach ensured that the features and language in the app were clinically relevant, easy to use, and culturally appropriate. The app content was developed and validated based on national clinical guidelines for chronic kidney disease and the context of experts in the field of nephrology, further strengthening the credibility and potential for replication of the app. The HD-SEMA app has also undergone a usability test with an average score of 82.17, which is included in the good/very good category (Grade B – Acceptable).

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Despite the growing use of mHealth in nephrology, few applications have been specifically designed for the Indonesian hemodialysis population, and even fewer have been empirically tested for their impact on quality of life. Therefore, this study aims to fill that gap by examining the effectiveness of HD-SEMA in improving the quality of life among hemodialysis patients through a structured, evidence-based digital intervention.

2. METHODS

Research Design

This research employed a quantitative approach with a quasi-experimental design using a two-group pre-test and post-test method. The independent variable in this study was the use of the HD-SEMA mobile application, while the dependent variable was the quality of life of hemodialysis patients. This design allowed researchers to compare changes in quality of life before and after the intervention within and between groups.

Population and Sample

The target population in this study consisted of patients undergoing hemodialysis at RSUP Dr. Hasan Sadikin Bandung. The sample size was determined using G*Power software version 3.1.9.7, applying a t-test for matched pairs (Means: difference between two dependent means), with the following assumptions: significance level (α) = 0.05, medium effect size (d) = 0.5, and power (1-β) = 0.95. Based on these parameters, the minimum required sample size was 54 participants. To anticipate a possible attrition rate of 10–15%, the final total sample size was increased to 60 participants, divided equally into two groups (30 intervention, 30 control).

This sample size is considered adequate for detecting a moderate effect in a two-group pre-post design, especially for behavioral health interventions, and aligns with recent methodological guidance for quasi-experimental designs (Suresh, 2021). It ensures sufficient statistical power to detect meaningful changes in outcomes, particularly when using repeated measures in digital health studies. The sampling technique used was convenience sampling, a non-probability method where participants are selected based on availability, accessibility, and willingness to participate. Researchers collaborated with dialysis unit nurses to screen for patients meeting the eligibility criteria. Those present during the data collection period and who provided informed consent were sequentially enrolled until the sample target was reached.

The inclusion criteria were: (1) patients undergoing routine hemodialysis, (2) conscious or hemodynamically stable, (3) aged ≥18 years, (4) ownership of an Android smartphone, and (5) the ability to read, write, and communicate effectively. The exclusion criterion was the presence of cognitive impairment that would interfere with comprehension or the use of the HD-SEMA application.

Instrument

Data on respondent characteristics—including age, gender, occupation, duration of hemodialysis, and inter-dialytic weight gain (IDWG)—were collected using a demographic questionnaire. The Kidney Disease Quality of Life Short Form 36 (KDQoL-SF36) was used to

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measure patients' quality of life. This instrument consists of 36 items covering five dimensions: symptoms/problems, effects of kidney disease, burden of kidney disease, physical health components, and mental health components. The overall score is derived from 24 items related to kidney-specific subscales, with scores ranging from 0 to 100—higher scores indicating better quality of life.

The validity and reliability of the KDQoL-SF36 Indonesian version were tested by Supriyadi et al. (2020), showing significant item-total correlations ($p < 0.001$). Additionally, the internal consistency reliability was confirmed with a Cronbach's Alpha ≥ 0.7 for all subscales, which meets the standard threshold for acceptable reliability. This supports the instrument's appropriateness for assessing quality of life in the Indonesian hemodialysis population.

HD-SEMA Application

Researchers developed the HD-SEMA application, which can be installed on Android smartphones. The HD-SEMA application is designed to provide health information and guidance to users via Android smartphones to improve self-management abilities and provide good changes for themselves. HD-SEMA contains education regarding Self-Management and Self-Care for HD patients, including several education such as Self-Management, Fluid Restriction Management, Diet/Nutrition Management, Medication Management, HD Adequacy, and Emotional Management (Figure 1). The HD-SEMA application has conducted a usability test with an average score of 82.17. It is included in the Acceptable Grade B (excellent) category, which shows that the score is relatively good and the application is suitable for use.

Table 1. Fill in the HD-SEMA Application Content

Application Content	
Self Management	1. Understanding Self Management 2. Self-Management Ability 3. Self Management Tips
Fluid Restriction Management	1. Understanding Fluid Management 2. Fluid Management Objectives 3. Impact of excess fluid 4. Daily Fluid Restriction 5. Inter-Dialysis Weight Loss (IDWG) 6. IDWG Classification 7. Fluid Management Tips
Diet Management	1. Diet Goals 2. Get to know the laboratory results 3. Food Management 4. Things to Pay Attention to 5. How to Make Your Diet Effective
Medication Management	
HD Adequacy	1. HD adequacy 2. Understanding Adequacy 3. Consequences of Inadequate HD 4. Influencing Factors 5. Tips
Emotion Management	1. The impact of stress and anger 2. Strategies for Overcoming Stress 3. Tips 4. Practice Relaxation Techniques 5. Relaxation Technique Training Videos

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Fig 1. HD-SEMA Application

Research Procedure

A total of 60 respondents were divided into two groups and interventions. The researcher approached the method by means of therapeutic communication, conveying the aims and objectives, explaining the research implementation procedures, explaining the rights of respondents, contracting time for participation in the research, and writing an informed consent letter. A pre-test was given to all groups, both the intervention group and the control group, before the intervention was carried out using the KDQoL-SF36 questionnaire.

This research was conducted face-to-face. Researchers will ask for willingness to become respondents through a consent form and conduct a pretest and explanation of the HD-SEMA application. Next, the researcher installed the HD-SEMA application on the respondent's cellphone. Then, the researcher explained how to use the HD-SEMA app. Then, the HD-SEMA application was implemented. Namely, the researcher instructed respondents to use the HD-SEMA application daily for 2 weeks. Every day, researchers remind you via message to use the HD-SEMA app. After two weeks of using the app, respondents were asked to fill out a post-test questionnaire. The intervention group trained two times a week for 30-40 minutes for one month, totaling eight sessions (4 weeks). In the control group, only intervention was given according to hospital practice. During filling out the questionnaire, respondents were guided by the researcher.

Table 2. Research Procedures

Time	Activity
The first week	1. Informed consent to research 2. Pre-test 3. Respondents are directed to install the HD – -SEMA application via the link provided 4. Explain the contents of the HD-Sema mobile application
The second and third week	1. Explain the contents of the HD-Sema mobile application 2. Instructed to use HD-Sema for 15 minutes per day
The fourth week	1. Post-test 2. Data Processing

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Data Analysis

Kolmogorov-Smirnov tests of all variables were performed to test the assumption of normal distribution. The normality test results of all data are typically distributed, so statistical tests can be carried out using parametric tests. Univariate analysis uses frequency distribution. Bivariate analysis is carried out using the Paired t-test and Unpaired t-test.

Ethical Clearance

This study gained ethical permission from the Ethic Committee STIKEP PPNI West Java Number III/034/KEPK/STIKEP/PPNI/JABAR/V/2024 on March 12th, 2024. Therefore, this study was able to be conducted because no human rights violation or harm to respondents should be taken into consideration from this study.

3. RESULT

The characteristics of respondents in this study were seen based on age and gender, education, occupation, and length of HD.

Table 3. Description of demographic characteristics of respondents in the intervention group (n=30) and control group (n=30)

Characteristics	Total (n=60) F(%)	Intervention N=30 (%)	Control n=30 (%)
Age (years)			
Mean±SD	45.32±11.40	42.70±11.60	47.93±10.74
Min-Max	20-70	20-66	23-70
Gender			
Men	38(63.3)	20(66.7)	18(60)
Women	22(36.7)	10(33.3)	12 (40)
Education			
Elementary	9(15)	4(13.3)	5(16.7)
Junior High School	9(15)	3(10)	6(20)
Senior High School	30(50)	16(63.3)	14(46.7)
University	12(20)	7(23.3)	5(16.7)
Work			
Work	34(56.7)	20(66.7)	14(46.7)
Does not work	26(43.3)	10(33.3)	16(63.3)
HD Old (Years)			
< 1	4 (6.7)	1(3.3)	3(10)
1-3	23 (38.3)	10 (33.3)	13 (43.3)
>3	33(55)	19(46.6)	14(46.7)

Table 3 shows that the distribution based on age characteristics corresponds to an average of 45 years. Based on gender, the majority is male, 63.3%. Based on education level, the majority is high school, 50%. Based on occupation, the majority are working, 56.7%. As for the length of time undergoing hemodialysis, most patients are more than 3 years old, 55%.

In Table 4, the Quality of Live scores for intervention and control group respondents are depicted. Description of Quality of Live in the pre-test intervention group with a mean value of 45.81 and SD 9.33 and post-test 50.03 and SD 8.24. Meanwhile, in the control group, before the intervention was given, the mean value was 45.92 and SD 5.53, and after the intervention, the mean was 45.81 and SD 5.34.

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Table 4. The difference in the average Quality of Live score for hemodialysis patients before and after intervention in the control and intervention groups

Variable	*Pre-test* (Mean±SD)	*Post-test* (Mean±SD)	95 % CI	*t*	*df*	*Sig*
Intervention Group	45.81±9.33	50.03±8.24	-4.89 – -3.10	-9.16	29	0.000
Control Group	45.92±5.53	45.81±5.34	-0.64 – -0.91	0.35	29	0.728

Based on Table 4, the Quality of Live scores for intervention and control group respondents are depicted. Description of Quality of Live in the pre-test intervention group with a mean value of 45.81 and SD 9.33 and post-test 50.03 and SD 8.24. Meanwhile, in the control group, before the intervention was given, the mean value was 45.92 and SD 5.53, and after the intervention, the mean was 45.81 and SD 5.34. The quality of Live identification results in the intervention group is between the average score of the pre-test and post-test with a value of t=-9.16 and a significance value of 0.000. Because the calculated t is negative and smaller than the t table, namely -9.16<1.69913, and the significance value is smaller than 0.05, the Ha hypothesis is therefore accepted. As for the control group, the average score between the pre-test and post-test was a t-value of 0.35 and a significance value of 0.728. Because the calculated t is positive and smaller than the t table, namely 0.35<1.69913, and the significance value is more significant than 0.05, the Ha hypothesis is therefore rejected.

Table 5. Analysis of self-management sub-variables before and after intervention

Domain	Before Intervention Mean (±SD)	After Intervention Mean (±SD)	*p-value*
Intervention			
List of symptoms/problems	66.02±9.06	69.83±8.70	0.000
Effects of kidney disease	43.70±10.68	49.40±2.62	0.000
Burden of kidney disease	38.13±5.94	40.01±4.11	0.000
Physical Health Components	35.7±6.58	40.56±3.03	0.000
Mental Health Components	45.51±7.82	50.37±2.96	0.000
Control			
List of symptoms/problems	66.35±2.02	66.48±1.61	0.354
Effects of kidney disease	44.57±2.26	44.64±2.08	0.690
Burden of kidney disease	38.63±2.70	38.26±2.8	0.183
Physical Health Components	35.13±2.69	35.16±2.39	0.839
Mental Health Components	44.93±3.56	44.53±3.56	0.965

Based on Table 5, it can be seen that there are significant differences in all Quality of Live sub-variables with p-values < 0.05 in the intervention group. In contrast, in the control group, there are no differences in all sub-variables with p-values> 0.05.

Table 6. The difference in the average score between the control and intervention groups regarding self-management of hemodialysis patients

Variable	N	Mean	Mean Difference	95 % CI	t	*Sig*
Post Intervention	30	50.03	4.22	3.23-10.43	3.810	0.000
Post Control	30	45.81				

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Based on Table 6 above, the mean difference value is 4.22, and the significance value is 0.000. This value shows the difference between the average self-management score of the intervention group and the control group.

4. DISCUSSION

According to Notoatmodjo (2012), two factors can influence knowledge: internal and external factors. Age is one of the internal factors that can influence a person's knowledge (Notoatmodjo, 2012). The more mature a person's level of maturity and strength will be in thinking and working. The results showed that the average respondent was 45 years old. This age is included in middle adulthood, where, at this time, a person can make independent adjustments to life and social expectations. Most people are able to determine their problems well enough to be relatively stable and emotionally mature. The results of this research are in line with those conducted by Ariyani (2019), showing that the majority of respondents were in the middle adult age category (40-60 years). A person aged 40 years and over will experience a progressive decrease in glomerular filtration rate until the age of 70 years, approximately 50% of normal (Ariyani, 2019). The kidneys begin to lose some nephrons, which are essential filters in the kidneys. So, the function of food absorption has significantly been reduced, and kidney function has begun to decline, which can cause kidney failure.

Basically, self-management activities must be carried out by all patients undergoing hemodialysis, both men and women. In this study, if we look at the number of respondents, the number of male respondents was greater than that of female respondents. This is supported by research conducted by Melastuti (2018) and Rostanti (2016), where the majority of respondents were male. The incidence of kidney failure in men is twice as high as in women because men predominantly often experience systemic diseases (diabetes mellitus, hypertension, glomerulonephritis, polycystic kidney disease, and lupus), as well as a family history of inherited diseases. Apart from that, women take better care of their health than men, their eating patterns are irregular, and most men like to drink alcoholic drinks; men also have higher creatinine levels than women (Melastuti, 2018)

In this study, if we look at the number of respondents, the number of respondents with a general secondary school education was more significant than those with other education levels. The majority of patients with chronic kidney failure who undergo hemodialysis have a high school education level, namely a percentage of 50.0%. This is because the lack of public knowledge and awareness for early detection in checking themselves at health service centers is the cause of the increase in CKD patients. After all, in the early stages, they do not experience specific complaints. Most patients come with complaints that are already serious and, at the time of further examination, are already in the terminal stage (stage 5).

In this study, the average quality of life for hemodialysis patients in the intervention group was 45.81, and the control group was 45.92. In Baraz et al.'s study, the mean was 46.69. In another study conducted by Pakpour et al., the mean was 44.35. In their research, the performance of the mental component was higher than the physical component. According to the research results of Rostami et al., the average quality of life for hemodialysis patients was 44.29. Therefore, the results of this and other studies indicate that the quality of life of hemodialysis patients is not at

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the desired level. It can be concluded that the psychological and physical quality of life in patients treated with hemodialysis for an extended period is poor (Rostami et al., 2011)

Although the quality of life of patients in this study was lower, the average quality of life after administering the HD-SEMA mobile application intervention improved significantly. The intervention group experienced a significant increase in all dimensions of quality of life for hemodialysis patients. Ahmadzadeh et al. (2017) analyzed a self-management program that was provided directly; there were significant differences between the two groups after the intervention regarding specific dimensions of quality of life, such as cognitive performance, symptoms, sleep status, dialysis, social support, and kidney complications (Ahmadzadeh et al., 2017) According to research by Bahadori (2014), it shows that providing self-management education improves all dimensions of quality of life for hemodialysis patients including physical function, physical role, body pain, general health, vitality, social function, mental health and emotional role with a P value <0.0001.

Android-based education is any planned effort to influence other people, whether individuals, groups, or society, so that they do what is expected through the teaching and training process using media in the form of Android applications. Providing material through engaging the press can make it easier for patients to receive information and minimize misunderstandings. According to Hartati (2016), another factor that can increase respondents' knowledge is that the media used in the form of images, writing, and sound strengthens respondents to increase compliance (Hartati & Winarti, 2020). The use of applications is the latest approach to convey health information and education to patients. Improvement in CKD is very slow, so it requires health education to be managed by patients themselves, regular monitoring of blood sugar, physical activity, eating and drinking patterns, and compliance with taking medication. Increasing information technology as a means of health education has developed recently; Information Technology (IT) based interventions help improve health information and assist communication with health service providers so that they can help patients in self-management.

Self-management education through mobile applications has shown significant improvements in the quality of life for hemodialysis patients. These applications provide patients with tools to manage their health more effectively, leading to better health outcomes. For instance, a study demonstrated that a smartphone application-based dietary self-management program significantly improved the quality of life in hemodialysis patients by enhancing their self-efficacy and managing biochemical indicators like serum phosphorus and potassium levels (Pack & Lee, 2021). Another study found that a mobile app-based self-management program improved patients' health-related quality of life, particularly in mental health components, and promoted self-care behaviors and self-efficacy (Lee et al., 2016)

Mobile applications designed for self-management education have been practical in enhancing the self-management abilities of hemodialysis patients. These applications often include features such as self-checking, message transfer through electronic medical records, and feedback, which help patients maintain physiological parameters within normal ranges and reduce non-adherence. Additionally, educational apps have been shown to significantly improve self-care performance and self-efficacy over time, indicating their potential for long-term benefits in patient management.

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The use of mobile applications for self-management education has also been associated with a reduction in complications related to hemodialysis. By providing real-time feedback and solutions, these applications help patients prevent complications such as edema, hyponatremia, and hyperkalemia, which are common in hemodialysis patients due to poor dietary management pack (Pack & Lee, 2021). Furthermore, self-management education has been shown to enhance patients' awareness of self-health care, thereby reducing complications and improving dialysis quality (Hosseini et al., 2023)

One of the key advantages of mobile applications for self-management education is their accessibility and convenience. Patients can use these applications anytime and anywhere, allowing them to manage their health conditions without the constraints of time or location. This flexibility is especially beneficial for elderly patients, who often face physical limitations or mild cognitive impairments that make traditional education methods less effective. In the usability testing of the HD-SEMA application, users reported a mean score of 82.17, which falls into the “acceptable to excellent” category, indicating high satisfaction and ease of use.

Furthermore, feedback collected during implementation showed that patients appreciated the structured and simple interface, while nurses acknowledged that the application helped reinforce education delivered during dialysis sessions. For instance, several patients mentioned that the reminder feature and daily self-monitoring log made them feel more in control of their fluid intake and medication schedules. Similarly, dialysis nurses noted that the app reduced repetitive education and empowered patients to ask more informed questions during consultations. These findings are consistent with other studies, such as Hosseini et al. (2023), which found that mobile educational apps improved self-efficacy and self-care behavior in hemodialysis patients and were well-received by healthcare providers.

5. CONCLUSION

The findings of this study demonstrated that the HD-SEMA mobile application significantly improved the quality of life of hemodialysis patients, as reflected by a statistically significant increase in KDQoL-SF36 scores in the intervention group (mean increase of 4.22; $p < 0.001$). The application effectively enhanced patients’ self-management abilities across multiple domains, including fluid control, nutrition, medication adherence, and emotional regulation. These improvements suggest that HD-SEMA is a promising tool for reducing complications and promoting independent disease management.

However, broader implementation of this application should consider several factors, such as variations in patient digital literacy, access to smartphones, and the availability of technical infrastructure in different healthcare settings. Addressing these challenges is essential to ensure equitable access and sustainable integration into clinical practice. Overall, HD-SEMA represents a valuable digital health intervention that can complement traditional education and support strategies in hemodialysis care, particularly when tailored to local patient needs and capacities.

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