Effectiveness of HD-Self Management (Hd-SEMA) Application on Self-Care Among Hemodialysis Patients

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Abstract

Objective: Self-care is a critical component of self-management in patients undergoing hemodialysis (HD). Management education using Android-based mobile technology can enhance self-care practices in HD patients. The HD-SEMA application aims to assist new HD patients and improve the self-care capabilities of long-term HD patients.

Method: This study investigated the impact of the HD-SEMA application on self-care in HD patients using a repeated-measurement quasi-experimental two-group pretest-posttest design conducted in West Java. The study included 60 respondents, divided into intervention and control groups. The intervention group received training sessions twice weekly for 30–40 minutes over four weeks, totaling eight sessions. The control group followed standard hospital practices. The Self-Care CKD Index Questionnaire was used as the research instrument.

Results: In the intervention group, pre-test mean scores for self-maintenance, self-management, and self-confidence were 18.17 (SD = 2.605), 12.60 (SD = 1.694), and 23.27 (SD = 4.008), respectively. Post-test mean scores improved to 19.67 (SD = 2.339) for self-maintenance, 13.87 (SD = 1.526) for self-management, and 25.63 (SD = 2.189) for self-confidence. A significant improvement was observed within the intervention group (p-value = 0.000, $p < 0.05$) and between the intervention and control groups (p-value = 0.000, $p < 0.05$).

Conclusion: The HD-SEMA application demonstrated significant potential in enhancing self-care behaviors among HD patients. Its effectiveness is influenced by factors such as usability, patient engagement, and the inclusion of features tailored to the specific needs of HD patients.

Keywords: hemodialysis, self-care, mobile health, HD-SEMA, chronic kidney disease

INTRODUCTION

Chronic kidney disease (CKD) arises from impaired kidney function, which, in its advanced stages, can result in death as the body fails to maintain fluid and electrolyte balance. When kidney function is compromised, treatment such as hemodialysis (HD) becomes necessary. HD is a therapeutic procedure used for patients with renal failure experiencing complications like pulmonary edema, hyperkalemia, and metabolic acidosis. This procedure helps reduce the levels of urea, creatinine, and other toxic substances in the blood (Blankestijn et al., 2023).

According to the World Health Organisation (WHO), in 2019, there were an estimated 1.5 million patients with HD worldwide, with the incidence increasing by 8% each year. Even in 2019, almost 4 million people in the world lived with HD therapy, and it is estimated that by 2030, HD patients could reach 5.5 million. According to Riskesdas 2018, the number of CKD patients in West Java 2018 reached 131,846 people and became the highest province in Indonesia. According to the

Bandung city health office, there were 13,209 cases of CKD in 2021. Meanwhile, according to the Indonesian Ministry of Health 2018, CKD patients undergoing HD in West Java were 33,828.

HD therapy is necessary for life in stage V chronic kidney disease patients, with 2 to 3 times every week. Patients must undergo HD for 4 to 5 hours in one therapy(Blankestijn et al., 2023).Patients undergoing HD therapy experience changes in their lives. Changes in HD patients consist of physical, emotional, and social challenges. Physical challenges can include fatigue, disturbed sleep patterns, hypotension, muscle cramps, infection at the vascular access, and anaemia. Patients must also adhere to strict therapeutic and dietary regimens, such as limiting salt, potassium, phosphorus, and fluid intake, which is often tricky (Kartiko et al., 2022). The emotional challenges usually felt due to the long and repetitive treatment process can trigger stress, depression, or anxiety. Some patients think they have lost their independence or everyday life (Ye et al., 2022). Social challenges include disrupting daily activities due to the strict HD schedule. The cost of HD therapy and additional treatments can be a financial burden, especially if the patient does not have adequate health insurance (Benetou et al., 2020).

Non-compliance in hemodialysis (HD) patients can lead to increased interdialytic weight gain (IDWG), hyperkalemia, complications, and higher mortality (Maimani et al., 2021; Yasin et al., 2024). Self-management is vital for optimizing health, reducing symptoms, and preventing complications (Ma et al., 2022). Effective self-care—such as fluid and sodium restriction—reduces IDWG and improves outcomes (Wayunah, 2022). Self-care is influenced by education, support, and adherence, contributing to better quality of life (Avanji et al., 2021; Kim & Cho, 2021). Management education using mobile apps offers a promising approach to improve self-care behavior in HD patients (Min & Park, 2020).

Mobile application HD Self Management (HD-SEMA) is an educational application for patients with chronic renal failure. This application has several educational features accompanied by explanations in a language that patients can easily understand. These features consist of self-management, fluid restriction management, nutritional diet management, medication management, emotional management, and HD adequacy. The advantages of the HD-SEMA application are that it can help patients find out about HD, especially new patients, and improve the self-care of patients who have been undergoing HD for a long time. In addition, this application does not use cellular data or internet quota to be more efficient.

Previous research in Korea concluded that a telephone-based self-management program by nurses could improve self-care behavior (Moon et al., 2018)—meanwhile, the effectiveness of a mobile application-based self-management program in elderly hemodialysis patients. Statistically significant improvements in sick role behavior, basic psychological needs, and Self-care were found in the experimental group ($p < 0.001$). The transtheoretical model-based WeChat health education program has a potentially positive effect on improving self-efficacy, time effects on partnership, self-care, emotion management with total self-management, and interaction effects on problem-solving and emotion management. Therefore, further research is still needed to confirm the impact of the mobile application Self Management (HD-SEMA) on Self-Care in HD patients. Addressing this issue, the study aims to explore whether the HD-SEMA mobile application for self-management significantly impacts healthcare outcomes in HD patients.

METHOD

Study Design

This study employed a quantitative approach with a quasi-experimental design, specifically a Two-Group Pretest and post-test setup. Conducted in the Hemodialysis Room of Dr. Hasan Sadikin Hospital (RSUP) in Bandung, the research aimed to assess the effectiveness of the HD-SEMA mobile application. Participants were divided into a control group and an intervention group. The independent variable was the HD-SEMA application focusing on self-care, while the dependent variable was self-care behavior in HD patients.

The study was carried out in January 2024 over a four-week data collection period.

Sample

The sample size for this study was calculated using G*Power Software version 3.1.9.4 to assess the effectiveness of the HD-SEMA mobile application for self-management education. The analysis utilized an *f* test with the statistical method of means: the difference between two dependent means (matched pairs), assuming an $\alpha = 0.05$, a medium effect size of 0.5, and a power level of 0.95. The required sample size was determined to be 54 participants. Accounting for an attrition rate of 10%–15%, the final sample size included 60 participants, evenly divided between the control and intervention groups (30 in each group).

The study employed convenience sampling for participant recruitment, conducted in the Hemodialysis Room at Dr. Hasan Sadikin Central General Hospital, Bandung, West Java. Inclusion criteria required participants to be over 18 years old, possess an Android smartphone, and have the ability to read, write, and communicate effectively. Exclusion criteria included patients with cognitive impairments.

HD-SEMA Mobile Application Design

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

Figure 1. HD-SEMA Application

Research Procedures

This research was conducted face-to-face, beginning with researchers obtaining informed consent from participants through a consent form. A pretest was administered, followed by an explanation of the HD-SEMA application. Researchers installed the HD-SEMA application on participants' mobile phones and provided detailed instructions on how to use it. Participants in the intervention group were instructed to use the HD-SEMA application daily for two weeks, with researchers sending daily reminders via messages to encourage consistent usage. After two weeks, participants completed a post-test questionnaire. Additionally, the intervention group received training sessions twice a week, lasting 30–40 minutes each, over one month, for a total of eight sessions (4 weeks). The control group, in contrast, received standard intervention according to hospital practices. During the questionnaire sessions, participants were guided by the researcher to ensure accurate completion of the data.

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

Instrument

The instrument in this study used the self-care CKD index questionnaire developed by Rieigeil, Carlsoin, and Glaseir (2000), which was subsequently revised by Rieigeil, Carlsoin, Seibeirn, Hicks, and Ronald (2004). It consisted of patient demographic data such as age, gender, education, employment level, length of HD time, and 25 questions for the self-care questionnaire. There are 10 (ten) question items on this instrument for the maintenance dimension with the assessment

using a like scale, namely 1 = never, 2 = sometimes, 3 = all the time, 4 = always or every day. One question item about symptoms of disease using the Likeirt assessment scale is 1 = not very quickly, 2 = somewhat quickly, 3 = quickly, and 4 = very quickly, 4 (eight) question items for the implementation of the assessment scale The questions are 1 = never, 2 = sometimes, 3 = all the time, and 4 = always, and 1 (one) question item for evaluation assessment using the Likert scale, namely 1 = not sure, 2 = somewhat sure, 3 = sure, and 4 = very confident. The self-care confidence dimension has 11 question items with a Likert assessment scale, namely 1 = not sure, 2 = somewhat sure, 3 = sure, and 4 = very sure.

The results of the self-care measurement score are based on a total reinforcement score of 25 – 100 (score 25-50= complete dependency, 51-76= partial dependency, 77-100= independent). The questionnaire is valid and reliable, with an r-alpha value of 0.0832. R alpha is greater than the r table (0.832 and >0.423), so all of these statements are declared reliable (Shu-Li Wang, 2016)

Data Analysis

This study used univariate analysis in frequency distribution to determine the characteristics of respondents, including age, gender, education, occupation, and length of HD. Bivariate analysis used paired t-tests and independent t-tests.

Ethical Clearance

Data collection was initiated following the approval of ethical clearance from the Institutional Review Board. The confidentiality of participant identities was strictly maintained.

RESULTS

Characteristics of respondents

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 (%)	*p-value*
Age (years)				
Mean±SD	44.62±11.300	42.10±11.357	47.13±10.849	0.084[a]
Min-Max	20-70	20-66	24-70	
Gender				
Men	35(56.5%)	20(32.3%)	15(24.2%)	1.000[b]
Women	25(40.3%)	10(16.1%)	15(24.2%)	
Education				
Elementary	6 (9.7%)	3 (4.8%)	3 (4.8%)	0.086[b]
Junior High School	7 (11.3%)	1 (1.6%)	6 (9.7%)	
Senior High School	34 (54.8%)	16 (25.8%)	18 (29.0%)	
Vocational School	5 (8.1%)	4 (6.5%)	1 (1.6%)	
University	8 (12.9)	6 (9.7%)	2 (3.2%)	
Work				
Work	28 (42.5%)	19 (30.6%)	9 (14.5%)	0.057[b]
Does not work	32 (51.6%)	11 (17.7%)	21 (33.9%)	
HD Old (Years)				
< 1	4 (6.5%)	1 (1.6%)	3 (4.8%)	0.361[b]
1-3	27 (43.5%)	13 (21.0%)	14 (22.6%)	
>3	29 (46.8%)	16 (25.8%)	13 (21.0%)	

Note : mean, frequency, indenpendent t-test[a], chi square[b]

Table 3 shows that the average age of respondents was 44 years. The majority of participants were male (56.5%), had a high school education (54.8%), were unemployed (42.5%), and had been undergoing HD for more than 3 years (43.5%). An Independent T-test and Chi-Square test were performed to analyze respondent characteristics, revealing no significant differences between the intervention and control groups in terms of age, gender, education level, occupation, and duration of HD.

Overview of HD Patient Self-Care

Table 4 Differences in self-care score of HD patients before and after intervention in the control group (n=30) and intervention group (n=30)

Variable	Total (n=60)	Intervention		Control	
	M±SD	M±SD	Min- max	M±SD	Min- max
Self care maintenance					
Pre test	18.17±2.605	18.07±2.572	13-14	18.27±2.667	14-23
Post test	18.87±2.521	19.67±2.339	16-25	18.07±2.477	13-23
Seilf carei manageimeint					
Pre test	11.85±1.774	12.60±1.694	10-17	11.10±1.539	8-14
Post test	11.82±1.742	12.60±1.694	10-17	11.14±2.603	9-15
Seilf carei coinfideince					
Pre test	23.40±3.315	23.27±4.008	17-32	23.53±2.501	19-28
Post test	25.95±4.264	23.63±2.189	19-28	28.27±4.593	20-39

Table 4 illustrates the self-care scores for respondents in the intervention and control groups. In the intervention group, the pre-test mean scores for self-maintenance, self-management, and self-confidence were 18.17 (SD = 2.605), 12.60 (SD = 1.694), and 23.27 (SD = 4.008), respectively. Following the intervention, these scores increased to 19.67 (SD = 2.339) for self-maintenance, 12.60 (SD = 1.694) for self-management, and 23.63 (SD = 2.189) for self-confidence. In the control group, the pre-test mean scores for self-maintenance, self-management, and self-confidence were 18.27 (SD = 2.667), 11.10 (SD = 1.539), and 23.53 (SD = 2.501), respectively. Post-test scores showed slight variations, with mean values of 18.07 (SD = 2.477) for self-maintenance, 11.14 (SD = 2.603) for self-management, and 28.27 (SD = 4.593) for self-confidence.

Differences in Self-Care of HD Patients Before and After Intervention in the Control and Intervention Groups.

Table 5 Differences in self-care of HD patients before and after intervention in the control group (n=30) and intervention group (n=30).

Variable	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	t	Mean Difference	P-value
Self care					
Intervention Group	52.93±6.570	60.33±7.048	7.085	7.400	0.000
Control Group	52.90±4.270	52.73±3.973	-1.000	-0.167	0.326

Table 5 shows that the intervention group had a significant difference in self-care before and after the intervention, with a p-value of 0.000. Meanwhile, the control group showed no significant difference in the self-care of HD patients before and after the intervention, with a p-value of 0.326.

Differences in Self Care Scores between the control and intervention groups of HD patients

Table 6 Differences in Posttest Self-Care Scores Between Control Group (N=30) and Intervention Group (N=30)

Variable	Mean±SD	Mean Difference	95%CI		*p-value*
			Lower	Upper	
Self care					
Post Intervensi	60.33±7.048				
Post Kontrol	52.73±3.973	7.600	4.643	10.557	0.000

Table 6 presents a comparison of post-test self-care scores between the intervention group (N = 30) and the control group (N = 30). The mean self-care score in the intervention group, which received the HD-SEMA application, was 60.33 (SD = 7.048), while the control group, which followed standard care protocols, had a lower mean score of 52.73 (SD = 3.973). The observed mean difference between the groups was 7.60 points, with a 95% confidence interval ranging from 4.643 to 10.557. The p-value of 0.000 indicates a statistically significant difference in self-care outcomes between the two groups ($p < 0.05$).
These results clearly demonstrate that the HD-SEMA application significantly improved self-care behaviors in patients undergoing hemodialysis. The large effect size and narrow confidence interval suggest that the intervention was both effective and consistent in enhancing self-care capacities, likely due to its structured educational content, user-friendly interface, and patient engagement features tailored for individuals with chronic kidney disease.

DISCUSSION

The findings of this study indicate a notable improvement in self-care among participants in the intervention group. Before the intervention, the pretest self-care score in this group was categorized as partial dependency, with a mean score of 52.93. Following the implementation of the HD-SEMA mobile application, the score significantly increased to 60.33. This improvement highlights the positive impact of the HD-SEMA app on enhancing self-care among HD patients. In contrast, the control group experienced a decline in self-care scores, potentially attributed to the absence of targeted interventions and the influence of inadequate emotional support or misinformation from unreliable sources.

Increasing patient knowledge regarding HD treatment is one of the leading indicators of the success of HD-SEMA Apps in supporting patient self-care. Better knowledge helps patients understand the importance of specific actions to maintain their health while undergoing HD therapy. Based on research by Hosseini et al. (2023), education via mobile applications can significantly improve patient self-care behaviour and self-efficacy over time. Several research results confirm the findings of this study. It is worth stating that a lack of awareness about self-care in patients leads to several complications and deaths (Hosseini et al., 2023).

Several studies have shown that mHealth applications can effectively improve self-care behaviors and self-efficacy in hemodialysis (HD) patients. For example, mobile-based interventions have been associated with improvements in sick-role behavior, psychological needs, and self-efficacy (Hosseini et al., 2023). However, patient engagement and app usability are critical for success, as low engagement can reduce effectiveness (Thompson et al., 2021). A scoping review identified five main functions of HD apps: dietary tracking, treatment adherence, lifestyle support, symptom monitoring, and education (Jebraeily et al., 2021), demonstrating the broad potential of digital tools to enhance self-management in HD care.

The feasibility and acceptability of mHealth interventions are also essential factors. A study evaluating mHealth interventions for managing hyperphosphatemia in HD patients found that while the programs were generally well-received, self-monitoring rates decreased over time (St-Jules et al., 2021). This indicates that while mHealth interventions can be feasible and acceptable, sustained engagement remains challenging. Understanding the perspectives of patients and healthcare

providers is essential for successfully implementing mHealth apps. A need analysis study revealed that patients and dietitians perceived renal diet apps as essential and were willing to use them provided they included features such as tailored assistance and usability(Lim et al., 2020). This underscores the importance of involving end-users in the app development process to ensure the apps meet their needs and preferences. This study has some limitations. First, a lack of randomization could affect the selection bias. The sample size was small, which may limit the generalizability of this study.

CONCLUSION

In summary, HD-SEMA apps have shown promise in improving self-care behaviors among HD patients. However, their effectiveness depends on factors such as usability, patient engagement, and the inclusion of features that address the specific needs of HD patients. Future research should focus on developing and testing these apps in diverse patient populations and settings to validate their effectiveness further and optimize their design for better patient outcomes.

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Conflict Of Interest

All authors declare no conflict of interest.

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