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Original Research Article

Effects of mHealth on kidney disease knowledge, stress management and adherence to treatment among hemodialysis patients in selected regions of Kenya

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ABSTRACT

Background: Chronic kidney disease (CKD) is a significant global health issue, causing over 1.1 million deaths annually, with prevalence rates especially high in Sub-Saharan Africa. Despite governmental efforts to provide hemodialysis treatment in places like Kenya, challenges such as late diagnoses, low public awareness, and a systemic shortage of healthcare workers persist. mHealth interventions, which have shown promise in over 30 low- and middle-income countries, offer a potential solution to enhance treatment adherence and improve self-care, although more research is needed to validate their efficacy compared to traditional educational methods.
Methods: This quasi-experimental study assessed mHealth interventions on hemodialysis patients in Kenya, targeting knowledge, treatment adherence, and psychosocial support. 132 adults participated from April 2021 to January 2023. The treatment group got mobile messaging for nine months; controls didn't. Data, gathered via questionnaires, was analyzed with Open Data Kit and statistical package for the social sciences (SPSS), maintaining ethical standards.
Results: The mHealth intervention study found no sociodemographic differences between groups, ensuring validity. Knowledge on kidney disease significantly increased in the intervention group by 68.6% compared to 2.3% in the control group. Medication adherence significantly improved ($p<0.001$), as did hemodialysis session attendance. Dietary compliance rates equalized over time. Depression levels significantly improved in the intervention group ($p=0.001$), while initial anxiety favored the control group but worsened ($p=0.006$). Overall, the intervention was effective in improving knowledge, treatment adherence, and mental health.
Conclusions: The study validated the effectiveness of mHealth in enhancing knowledge on kidney diseases, improving medication and treatment adherence, and reducing depression among hemodialysis patients.

Keywords: mHealth, Hemodialysis, Knowledge, Adherence, Depression, Anxiety

INTRODUCTION

Chronic kidney disease (CKD) causes more than 1.1 million deaths each year and is a leading global cause of death.[1] The disease is notably prevalent in Sub-Saharan Africa, with rates of about 13%, exceeding even those of HIV.[2] Lack of resources and weak healthcare systems further aggravate the impact of CKD in these regions. It is clear that CKD is associated with age, lifestyle choices, and comorbidities like diabetes. Further, late diagnosis and low public awareness contribute to poor clinical outcomes.[3,4] Over time, if untreated, CKD progresses to the end stage renal disease (ESRD) and patients in this category require hemodialysis to sustain their life. In Kenya, Government initiative, the managed equipment service program aimed at improving access to essential treatments like hemodialysis.[5] Despite the availability of diagnostic and treatment equipment, a systemic shortage

of human resources for health still exists, affecting the overall quality of services in Kenya. mHealth therefore may serve a supplementary role in patient care, as it has demonstrated potential for improved global management of CKD. mHealth has demonstrated benefits in over 30 low- and middle-income countries and could particularly enhance treatment adherence and overall quality of life (WHO, 2011).

Patient education is critical for managing ESRD and improving treatment adherence. Remarkably, educational interventions show promise for improving outcomes among patients undergoing hemodialysis.[7,8] Knowledge gaps can result in poor treatment adherence and heightened risk of medical complications. Interventions that provide motivational education and psychosocial support are therefore essential for fostering self-management behaviors.[9] Despite better access to renal therapies in Kenya, it is clear that there is a lack of effective patient education.[10] Notably, patients have expressed the need for more actionable advice and a comprehensive approach to education.[11] However, these patients often face issues like fluid overload and insomnia, emphasizing the need for self-care.[12] Adherence to medication and lifestyle changes is particularly important for late-stage CKD patients.[13]

Self-care is a significant challenge among hemodialysis patients and contributes to poor clinical outcomes Patients often struggle with dietary compliance, which can lead to severe complications. Targeted education strategies are essential for improving self-care and clinical outcomes.[14] Nurses play a vital role in patient education, especially concerning the complexities of treatment. Patients dealing with hemodialysis often face mental, social, and economic challenges. Effective educational programs can bridge the gap between clinical care and self-care, ultimately improving health outcomes.

Adherence to hemodialysis is a complex issue affecting both healthcare costs and clinical outcomes. Non-adherence can result in complications like lung edema and hypertension.[15] A multi-pronged approach, including both system improvements and individualized patient education, is therefore essential for better management. Patient outcomes are significantly influenced by adherence, which in turn is affected by factors like age and socioeconomic status.[16] Non-adherence has potential to lead to improper medication administration and overall increased healthcare costs. mHealth intervention offer a new avenue for improving patient adherence. They provide features for monitoring, education, and symptom management. Despite their promise, more research is needed to compare their efficacy against traditional educational methods to assess their efficacy compared to traditional methods.

Objectives

Objectives of the study were: to examine the effects of mHealth on the knowledge on self-management by hemodialysis patients', to investigate the effects of mHealth intervention on adherence to hemodialysis treatment among hemodialysis patients, and to evaluate the effects of mHealth intervention on stress management among hemodialysis patients.

METHODS

The study employed a quasi-experimental design with pre-test and post-test measurements, focusing on the effect of mHealth interventions on hemodialysis patients. The treatment group received interventions in three categories: knowledge transfer, adherence promotion, and psycho-social support for managing anxiety and depression. The control and treatment groups both participated in pre- and post-tests to compare the effect of the interventions. To minimize time-related confounding biases, simultaneous testing was conducted in both groups.

The research took place in various counties in the Eastern and Central regions of Kenya, specifically in Embu, Meru, Nyeri, Kirinyaga, and Kiambu. These areas were chosen due to their high rates of hypertension, obesity, and diabetes-key risk factors for chronic kidney diseases. In addition to the health-related criteria, the regions were also selected because they are ethnically homogenous and have high mobile phone network coverage, making them ideal for a study involving mobile health interventions.

The study population consisted of adult hemodialysis patients attending dialysis in selected public health facilities. Using purposive sampling for the general study area and simple random sampling for treatment and control group centers, a total of 132 patients were estimated to be part of the baseline study. Several inclusion and exclusion criteria were applied; notably, only adult patients undergoing chronic hemodialysis in the selected facilities were included, while pregnant women and those with cognitive or mental disorders were excluded. Data collection spanned from April 2021 to January 2023, with measurements taken at baseline and 9 months post-intervention. The research study focused on the impact of mobile health (mHealth) interventions on patients undergoing dialysis for kidney disease, specifically knowledge on management of kidney diseases, adherence to hemodialysis and stress management. The sample size was determined to be 128, with equal numbers in the treatment and control groups.

The study methodology involved a well-defined process for allocating treatment and control groups, conducting interventions, and follow-ups. Patients in the treatment group received targeted mobile messaging covering key areas like medication, nutrition, and coping mechanisms over a 9-month period. The control group was administered questionnaires but did not receives any mobile interventions. Data was collected using comprehensive questionnaires that included social demographic data, knowledge of hemodialysis, psychosocial wellness, and adherence to treatment. The

questionnaires were pretested for validity and reliability, and ethical considerations like informed consent and confidentiality were also considered.

For data management and analysis, the study utilized the Open Data Kit (ODK) platform and statistical package for the social sciences (SPSS) software. The research aimed to test the null hypothesis that there is no change in in the knowledge, adherence and depression and anxiety scores. Ethical considerations were thoroughly addressed, with approvals sought from relevant bodies and informed consent obtained from participants.

RESULTS

Sociodemographic characteristics of the study participants

The study's findings indicate that there were no statistically significant differences between the intervention and control groups in terms of baseline and endpoint characteristics, including sex, marital status, educational attainment, employment status, and age. For instance, both groups had more male respondents than female ones, and the majority of individuals in both groups had secondary education. In terms of employment, the vast majority in both the intervention and control groups were unemployed, with smaller proportions being employed, retired, or engaged in personal business. Regarding age and income, although the mean age and mean monthly earnings differed between the control and intervention groups, these differences were not statistically significant. Specifically, the mean age in the control group was 53.70 at the start of the study and 54.61 at the end, compared to 56.32 at the start and 58.22 at the end in the intervention group. Similarly, while the control group had a higher monthly average income compared to the intervention group, t-test outcomes showed this difference was not statistically significant.

In summary, the lack of significant sociodemographic differences between the intervention and non-intervention groups at both the start and end of the study is noteworthy. These results provide valuable context for understanding the study's overall findings. The demographic makeup in terms of gender distribution, marital status, education level, employment status, age, and income level was similar for both groups, thereby minimizing potential confounding variables that could affect the study outcomes.

The effect of mHealth on knowledge on kidney disease

Table 2's findings show the respondents' knowledge of kidney disease at the beginning and end of the study in both the intervention and control groups. At baseline, all respondents in both groups had no knowledge of kidney disease. Seemingly, at end line, Between the non-intervention and groups receiving the intervention, there was a statistically significant variation in the knowledge of kidney disease. Regarding the intervention group, 68.6% of respondents gained knowledge on kidney disease, while in the control group, only 2.3% of respondents acquired this knowledge. The χ^2 test indicated a strong association between the intervention and increased knowledge on kidney disease (χ^2=43.400, p<0.001).

These findings demonstrate how the intervention was successful in raising participants' awareness of kidney disease. With regard to knowledge, the groups receiving intervention demonstrated a substantial advancement, with the majority of respondents becoming knowledgeable about kidney disease. On the other contrary, the control group had minimal changes in knowledge levels. The results imply that the intervention significantly improved the target population's understanding of kidney disease.

mHealth intervention's impact on haemodialysis adherence

There was no discernible difference in adherence at the beginning to taking medication among the respondents (p=0.305) while at end line the difference in medication compliance was statistically significant (p=0.001). Between baseline and end line, there was a significant difference in respondents' adherence to participating in dialysis treatment sessions. The intervention group had higher adherence to haemodialysis sessions than the control group, which made the difference in adherence to sessions more noticeable at the end of the study. Between the control group and the intervention group, there was a substantial disparity in compliance to diet and limited water intake at the beginning of the study (p=0.001). The control group had significantly higher adherence than the group receiving the intervention. At the end line, there was no discernible difference between the control and intervention groups' dietary restrictions. This essentially demonstrates that the intervention group's rates of compliance to dietary restrictions had increased by the time the intervention came to an end.

The effect of a mobile health intervention on management of stress (depression and anxiety)

The results are shown in Table 4, which includes the anxiety and depression scores at the start and end of the intervention and control groups. There was no discernible difference in levels of depression between the non-intervention and treatment groups at baseline (p=0.130). Notably, a substantial number (40%) of respondents in the non-intervention group had moderately severe depression, while 47.2% those in the intervention group had mild depression.

However, a significant difference in depression status between the untreated group and groups receiving intervention emerged at the end line (p=0.001). In contrast to those in the groups receiving intervention, the majority of those who participated in the untreated group had mild to moderate depression. In comparison to baseline, there

was a discernible decline in the proportion of respondents who had moderate to severe or severe depression at the end of the study.

There was a substantial disparity (p=0.006) between the non-intervention and groups receiving intervention in terms of anxiety between baseline and endpoint, favoring the control group. The difference in anxiety levels between participants in the control group, however, became slightly more pronounced at the end line compared to baseline.

These results demonstrate how the intervention affected those who took part in the groups receiving intervention mental health. According to the table, the treatment group's depression levels significantly improved over the control groups, with a higher percentage of respondents reporting milder symptoms.

Additionally, the greater disparity between the groups at the end line suggested that the intervention had a more significant impact on minimizing anxiety levels.

Table 1: Sociodemographic characteristics of respondents in control and intervention group at baseline and end line.

Variables	Baseline, f (%)				End line, f (%)			
	Control	Interven-tion	χ^2	P value	Control	Interven-tion	χ^2	P value
Sex								
Female	23 (46.0)	18 (34.0)	1.556	0.212	21 (42.9)	21 (41.2)	0.029	0.865
Male	27 (54.0)	35 (66.0)			28 (57.1)	30 (58.8)		
Marital status								
Single	5 (10.0)	1 (1.9)	4.059	0.255	5 (10.2)	1 (2.0)	4.163	0.244
Married	40 (80.0)	44 (83.0)			40 (81.6)	42 (82.4)		
Divorced	3 (6.0)	3 (5.7)			2 (4.1)	3 (5.9)		
Widowed	2 (4.0)	5 (9.4)			2 (4.1)	5 (9.8)		
Education level								
No education	0 (0)	6 (11.3)	6.261	0.181	0 (0)	4 (7.8)	4.221	0.377
Primary	11 (22.0)	12 (22.6)			12 (24.5)	12 (23.5)		
Secondary	27 (54.0)	25 (47.2)			25 (51.0)	25 (49.0)		
College (cert/dip)	10 (20.0)	8 (15.1)			9 (18.4)	8 (15.7)		
University	2 (4.0)	2 (3.8)			3 (6.1)	2 (3.9)		
Employment status								
Unemployed	27 (54.0)	34 (64.2)	3.154	0.369	26 (53.1)	34 (66.7)	3.680	0.451
Employed	5 (10.0)	8 (15.1)			7 (14.3)	4 (7.8)		
Retired	9 (18.0)	5 (9.4)			8 (16.3)	8 (15.7)		
Personal business	9 (18.0)	6 (11.3)			8 (16.3)	5 (9.8)		
Age								
Mean	53.70±16.34	56.32±13.56			54.61±16.11	58.22±12.80		
T statistic	-0.886				-1.235			
P value	0.378				0.220			
Average monthly income								
Mean	20281.18±25258	11611.76±15219.8			20591.84±25127.94	11766.67±15687.30		
T statistic	8772.42				2.097			
P value	0.006				0.039			

Table 2: Knowledge on kidney disease among respondents in control and intervention group at baseline and end line.

Variables	Baseline, f (%)				End line, f (%)			
	Control	Intervention	χ^2	P value	Control	Intervention	χ^2	P value
Knowledge								
Not knowledgeable	44 (100)	53 (100)			42 (97.7)	16 (31.4)	40.639	<0.001
Knowledgeable	0 (0)	0 (0)			1 (2.3)	35 (68.6)		

Table 3: Adherence to haemodialysis treatment among respondents in control and intervention group at baseline and end line.

Variables	Baseline, mean±SD				End line, mean±SD			
	Control	Intervention	T test	P value	Control	Intervention	T test	P value
Medication	2.64±0.63	2.54±0.34	1.033	0.305	2.76±1.07	3.73±0.57	-5.644	<0.001
Attendance at HD sessions	1.38±0.45	1.54±0.45	-1.777	0.079	1.37±0.47	1.63±0.34	-3.155	0.002
Diet/fluid restrictions	1.46±0.60	0.86±0.81	4.248	<0.001	1.42±0.62	1.45±0.82	-0.226	0.822

Table 4: Stress levels among respondents in control and intervention group at baseline and end line.

Variables	Baseline, f (%)				End line, f (%)			
	Control	Intervention	χ^2	P value	Control	Intervention	χ^2	P value
Depression level								
Minimal symptoms	3 (6.0)	2 (3.8)	5.649	0.130	3 (6.1)	6 (11.8)	16.418	0.001
Mild	13 (26.0)	25 (47.2)			11 (22.4)	27 (52.9)		
Moderate severe	20 (40.0)	18 (34.0)			20 (40.8)	15 (29.4)		
Severe	14 (28.0)	8 (15.1)			15 (30.6)	3 (5.9)		
Anxiety								
None	7 (14.0)	20 (37.7)	7.494	0.006	6 (12.2)	19 (37.3)	8.337	0.004
Probable anxiety disorder	43 (86.0)	33 (62.3)			43 (87.8)	32 (62.7)		

DISCUSSION

The mHealth intervention and knowledge on kidney diseases

The study examined the impact of mHealth interventions on the knowledge of kidney diseases among haemodialysis patients in specific counties in Kenya. Results demonstrated a significant increase in disease knowledge within the intervention group, with a rise from 0% to 35%. In contrast, the control group only experienced a minor 2.3% improvement. The intervention group's knowledge increased by a factor of 4.601, covering critical areas like medication, dietary changes, targeted blood pressure, and fluid restrictions. These findings underscore the potential of mHealth initiatives in enhancing patient education and self-management, potentially leading to better quality of life and disease prognosis. This is in line with similar research such as the study by Sarker et al in India, which also reported mHealth's positive influence on kidney disease knowledge.[17] Other studies, like Feizalahazadeh et al, found that multimedia applications can enhance treatment adherence through better patient education.[18] Studies like those by Jayanti et al and Saadatifar et al further support the idea that increased patient knowledge can lead to more effective self-management, such as control over food and fluid intake, which in turn may reduce the frequency of haemodialysis treatments.[19,20]

However, the study also highlighted that the effectiveness of mHealth interventions can be influenced by various factors. Research by Wilson et al noted that older adults often face challenges in utilizing mHealth due to limited technology familiarity, cognitive issues, and physical constraints.[21] Similarly, a study by Kumar et al found that digital literacy can significantly affect the success of mHealth initiatives.[22] Patients lacking sufficient digital literacy may find it difficult to interact with digital platforms. Therefore, these considerations suggest the need for contextual factors to be considered when implementing and recommending mHealth interventions for haemodialysis patients.

mHealth interventions and stress management (depression and anxiety)

Patients undergoing hemodialysis have been found to experience higher rates of depression compared to individuals with other chronic health conditions.[23] This study revealed that mHealth interventions notably decreased depression levels among hemodialysis patients (p=0.001). This aligns with a recent meta-analysis indicating that mobile-based applications are effective in alleviating psychosocial symptoms like depression and anxiety.[24] Given that depression is associated with adverse outcomes such as increased fatigue and lower quality of life among hemodialysis patients, mHealth interventions could be a valuable asset in improving patient well-being. However, it's crucial to note that these applications are not intended to replace psychiatric care but to serve as a cost-effective, accessible, and low-intensity adjunct to traditional treatments.[24,25]

In contrast, the study found that mHealth interventions did not significantly impact anxiety levels among the hemodialysis patients. The anxiety prevalence in the study's patient group ranged between 12% and 52%, which is consistent with previous research.[26] Moreover, the observed 45.7% anxiety rate among a comparable patient cohort in New York mirrored the findings of this study.[27] While mobile interventions have been shown to mildly reduce anxiety in the general population and more notably in individuals with elevated symptoms, they didn't yield similar results here.[25,28] A meta-analysis of randomized controlled trials also found that mobile interventions effectively lowered anxiety among patients with mental health issues.[29] The study suggests that the non-significant effect on anxiety could be attributed to the limited duration of the intervention or that the anxiety experienced by the patients might not be directly related to their illness.

The mHealth intervention and adherence to haemodialysis treatment

The study found that mHealth interventions significantly improved medication adherence among haemodialysis patients. Specifically, patients in the intervention group were 1.062 times more likely to stick to their medication regimen by the study's end. This aligns with earlier research showing the positive impact of mobile-based messaging on treatment adherence in similar patient populations.[12,30]

Before the intervention, both groups showed similar medication adherence levels ($p=0.305$). However, adherence increased notably in the intervention group afterward ($p<0.001$). This is important as non-adherence can lead to higher readmissions, mortality rates, and healthcare costs.[31] The study further found that mobile alerts, which provided reminders for upcoming hemodialysis sessions and potential side effects, led to increased attendance, corroborating the findings of an American study using the mobile app Expdialysis.[30] Financial limitations, often cited as a reason for missing hemodialysis sessions in low- and middle-income countries, didn't deter adherence among the low-income participants in the intervention group.[32] Additionally, the intervention group exhibited higher adherence to diet and fluid restrictions, supported by previous studies that also noted improved clinical and laboratory measures, such as serum potassium and phosphorus levels, in similar settings.[32]

While the study emphasized the potential benefits of mHealth, it also acknowledged ongoing debates regarding its effectiveness, which may be influenced by age, digital literacy, and personal motivation. Elderly individuals often face challenges in utilizing technology, potentially affecting mHealth's efficacy.[33] Likewise, those with low digital literacy may struggle to benefit from such interventions. Furthermore, the effectiveness of mHealth interventions can be compromised if the patients are not intrinsically motivated.[34,35]

CONCLUSION

The study validated the effectiveness of mHealth in elevating knowledge about kidney diseases, bolstering medication and treatment adherence, and diminishing depression among hemodialysis patients and also provided concrete evidence as the intervention group showcased significant improvements in disease awareness, medication and dialysis sessions adherence. While certain facets like dietary compliance remained consistent and initial anxiety readings were more favorable for the control group, the overarching beneficial outcomes solidify the potency of mHealth interventions. This research, therefore, advances the understanding of mHealth potential as an adjuvant to traditional educational approaches and sets stage for future investigations for mHealth application in different contexts.

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