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Effectiveness of Short Message Service Support on Adherence to Chemotherapy Treatment among Patients Attending Cancer Treatment Facilities in Kenya

Nebert Kiguhe Mchidi[1*], John P. Oyore[2], Gordon Ogweno[3]

[1]Department of Specialized Surgery, Kenyatta National Hospital, Nairobi, Kenya
[2]Department of Community Health and Epidemiology, School of Public Health, Kenyatta University, Nairobi, Kenya
[3]Department of Medical Physiology, School of Medicine, Kenyatta University, Nairobi, Kenya
Email: *nebertnelly@gmail.com

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Abstract

Introduction: Cancer is a chronic debilitating disease that unnerves patients, communities, and nations. At some point in cancer patient's disease experience, chemotherapy is used, and the patient is expected to adhere to treatment to improve survival and quality of life. **Methods:** This multisite Cluster Randomized Trial (CRT) evaluated the effectiveness of mobile phone Short Message Service (SMS) support on the adherence to treatment schedules among adult cancer patients in Kenya. Data was collected using questionnaires. Ethical approvals were obtained from relevant Ethical Review Boards (ERBs). **Results:** The mean adherence was 83%. There was a significant difference between treatment arms in relation to the adherence. The intervention arm had a higher mean adherence difference, $M = 3.913$, 95% CI 2.632 - 5.193, $t(402) = 6.006$, $p \leq 0.001$), with Cohen's d = 0.60. Although not significant, (χ^2dd = 0.151, df = 1, p = 2.064), more women were perfect adherers than males. Perfect adherers were satisfied with SMS support (χ^2dd = 7.620, df = 1, p = 0.06), were in the intervention arm (χ^2dd = 22.942, df = 1, p ≤ 0.001), and had trust in the care provider (χ^2dd = 10.591 p ≤ 0.001). SMS support was not significant in the multivariate analysis but had an estimated effect size of 0.958 (z = 1.424, p = 0.154, CI = 0.242 - 3.781), indicating that mean adherence was slightly better in the presence of the intervention. **Conclusions:** SMS-support intervention has demonstrated superiority in influencing adherence. Further, health system-related factors have a significant influence on the adherence to chemotherapy treatment. Interventions to re-design health systems that are responsive to unmet care needs of cancer patients must be explored.

Keywords

Adherence, Cancer, Symptom Distress, Quality of Life, Medication Possession Ratio, Short Message Service, Survivorship

1. Introduction

Cancer is characterized by abnormal growth and proliferation of cells, prompted by genetics or exposomes, that result in fundamental cellular changes that disregard standard rules of cell division, culminating in varying degrees of pathology specific to the physiological and anatomical characterization of the affected cells [1]. It is estimated that 14.1 million incident cases and 8.8 million cancer deaths occurred globally in 2015 [2], while in 2018, there were 18.1 million new cases and 9.6 million cancer deaths worldwide [3], making cancer the second cause of mortality after cardiovascular diseases. By 2025, cancer incidence is projected to surpass 20 million cases and 11.4 million case mortality. Of these, there will be a 59% increase in incidence and a 68% increase in mortality in low- and middle-income countries [4]. The rapid increase in cancer and other non-communicable diseases (NCDs) in low-income countries (LICs) has been attributed to increased exposures to risk factors such as tobacco use, harmful use of alcohol, and environmental carcinogens. Urbanization, Westernization, and the evolving profiles of risk factors that occur in LICs against the background of marked demographic changes will see the cancer burden increase in economically poorer regions of the world [5] [6].

A cancer diagnosis is unnerving for the patient, society, and the health care system, and takes a heavy toll on adjustment to life. In Kenya, 80% of cancer diagnoses are made at stage 3 or 4, meaning that patient survival depends on the limited option of chemotherapy [7]. Chemotherapy treatment requires a multidisciplinary and multipronged approach, with patient adherence to the scheduled treatment regimen being central to maximizing the beneficial effects of treatment and improving quality of life. Although adherence is important, chemotherapy and cancer generate a negative cluster of symptoms called cancer distress [8] that if ineffectively handled, may result in nonadherence. Nonadherence to treatment alters exposure to chemotherapy, chemotherapy effectiveness, and the clinical course of cancer management [9], invariably resulting in poor outcomes [10] [11]. Although the sufficient component causal factors for adherence to chemotherapy have a non-linear relationship and are universal [12], it is hypothesized that adjusting even a small component in the adherence complex has a positive impact on the overall adherence [13] [14] [15] [16].

While caregivers in cancer treatment facilities offer cancer treatment-related health literacy, most of the treatment-related incidental care needed by cancer patients is at home; because treatment-related symptoms such as arthralgia, cancer-related fatigue, and fever occur within 48 to 72 hours after chemothera-

py, way after the patient has left the hospital setting. This realization informed the quest to move cancer care from the usual point of care to the point of greater need, the patient's daily space, which is consistent with the policy direction contemplated in the Kenyan community health strategy. This study tested the effectiveness of SMS support in adherence to chemotherapy treatment, based on the successes recorded in other diseases [17] [18] that have tested mobile technology to improve behavioral approaches to health to improve adherence to chemotherapy treatment.

2. Materials and Methods

2.1. Study Design and Setting

This was a two-arm CRT conducted between June 2021 and December 2022 in eight (8) cancer treatment facilities in Kenya that recruited 538 participants who were starting intravenous chemotherapy on the outpatient basis. Recruitment of participants was prospective and began on 15 June 2021 and ended on 22 December 2022. Cumulatively the trial ran for a period of about 19 months. The clusters included Kenyatta National Hospital (KNH), Moi Teaching and Referral Hospital (MTRH), Kakamega County General Referral Hospital, Jaramogi Oginga Odinga Teaching and Referral Hospital (JOOTRH), Coast General Teaching and Referral Hospital, Machakos County Referral Hospital, Texas Cancer Center, and Mp Shah Hospital. The allocation of clusters to the treatment arms was done randomly with KNH, JOOTRH, and MTRH being assigned to the intervention arm while the rest were assigned to the control arm.

2.2. Participants and Sample Size

The trial was carried out among adult patients receiving intravenous chemotherapy on an outpatient basis. To achieve a power of 80% in detecting the difference in adherence due to the intervention, a sample size of 404 respondents was used (see Appendix). The trial included adult participants who were starting intravenous chemotherapy and who consented to participate in the trial. After meeting the inclusion criteria, all participants in each cluster received arm specific SMS until the end of individual treatment cycles. At the end of the treatment cycles, participants were randomly selected to answer the questionnaire (See Appendix) regarding the intervention and adherence to chemotherapy treatment.

2.3. SMS-Support Intervention

The intervention used the mobile phone short message service. The intervention arm received a two-part text message about 1) general cancer survivorship self-care and 2) reminders about keeping clinic appointments for scheduled chemotherapy while the control arm received a text message regarding keeping clinic appointments for scheduled chemotherapy only. The educational content of the SMS was based on the American Society of Clinical Oncology (ASCO) guidelines [19].

2.4. Outcome Measure

The dependent variable, adherence to chemotherapy treatment, was operationalized using the medication possession ratio (MPR) [20]. MPR was calculated as the number of days a participant was to receive the chemotherapy regimen according to the prescription, divided by the number of days elapsed from the first to the last dose of the regimen [21] [22] then converted to percentage, which represented the observed adherence. Participants who had an MPR > 85% were considered to have had perfect adherence to chemotherapy treatment.

2.5. Data Collection

Data was collected using a questionnaire comprising questions on individual factors, disease-related factors, healthcare system-related factors, and comorbidity. The questionnaire contained questions adapted from validated psychometric tools on quality of life [23], Charlson comorbidity scale [24] and symptom distress scale [25].

2.6. Statistical Analysis

Data was analyzed using (Statistical Package for the Social Sciences) SPSS version 26 (IBM Inc.®) and (Statistical Analysis Software) SAS to get descriptive statistics. The R program (v4.2.2) was used to calculate the adjusted Chi-squared test [26] to determine the significance of the difference between binary variables. The generalized linear mixed model with robust covariance estimation [27] was used to assess the effect of the intervention on adherence to chemotherapy. A test with p-value < 0.05 was considered statistically significant.

2.7. Ethical Considerations

The trial was approved by the National Commission for Science, Technology, and Innovation (NACOSTI). All study cites that had an institutional ethics review board (IERB) issued ethical approval for the trial (see appendix), one cite gave permission because it lacks and IERB. Participation in the trial was voluntary, and participants who felt the need to stop receiving the intervention were free to withdraw without suffering negative consequences. The PI formulated a Data Safety Management Board (DSMB) drawn from experts in human subject research, ethicists, cancer treatment, and clinical psychology to monitor any reported adverse event from the trial (*no adverse event was directly linked to the trial*). Participants in the control arm suffered no more than minimal harm, given the behavioral nature of the trial. All data collected was de-identified where necessary and kept in a password-protected domain.

3. Results

3.1. Respondent Characteristics

The mean age of the trial participants was 52.9 ± 12.9 years. Most of the participants, 68% (n = 275), were women, 75.5% (n = 305) were married, 47.3% (n =

191), were primary school leavers, 53.2% (n = 215), reported being in the lower financial freedom category and 66.6% (n = 269), were not employed. Additionally, the majority of 84.2% of participants (n = 340) said they had a regular person who supported them through cancer survivorship. Among the 84.2% (n = 340), who had one regular person who helped with cancer-related needs, the majority, 42.1% (n = 143) identified the spouse as the regular support person.

All participants (n = 404) reported that they relied on the National Hospital Insurance Fund (NHIF) for treatment. A minority, 6.2% (n = 25) of the participants, had an additional health insurance cover. There was a lack of privacy for the majority, 58.7% (n = 237) of the participants in the consultation rooms. While there was a lack of privacy, the majority, 83.4% (n = 337), reported not being bothered by the lack of privacy. The majority, 74.8% (n = 302) of the participants, strongly felt involved in the care decisions of healthcare workers about them. Although most respondents felt that healthcare workers gave them enough time to ask questions about the care provided, there was a preponderance of nurses 66.8% (n = 277) giving adequate time compared to doctors 44.8% (n = 181). Some of the respondent characteristics are shown in Table 1.

Table 1. Demographic and characteristics of the participants (n = 404).

Characteristic		Frequency (%)
Sex	Male	129 (32)
	Female	275 (68)
Marital status	Married	305 (75.5)
	Single	46 (11.4)
	Widowed/Widower	31 (7.7)
	Divorced	14 (3.5)
	Separated	8 (2.0)
Highest level of education	Primary school	191 (47.3)
	Secondary School	133 (32.9)
	Diploma	65 (16.1)
	University degree	15 (3.7)
Financial leeway	Low	215 (53.2)
	Middle	163 (40.3)
	Upper	26 (6.4)
Employment status	Not employed	269 (66.6)
	Self-employed	75 (18.6)
	Formally employed	60 (14.9)
Have one regular support person.	Yes	340 (84.2)
	No	64 (15.8)

3.2. Adherence to Chemotherapy Treatment

The mean adherence to chemotherapy treatment was 83.0% ± 6.8%, with the lowest adherence being 60% and the highest 98.0%. Respondents in the intervention had an MPR of 84.1% compared to 80.7% in the control. An independent t-test showed that there was a statistically significant difference in MPR between arms, and the participants in the intervention had a higher mean difference, M = 3.913, 95% CI [2.632 - 5.193], t (402) = 6.006, p ≤ 0.001, with a moderate design effect of 0.60 (95% CI = 0.39 - 0.77). Overall, 39.9% (n = 161) of the respondents had a MPR > 85% and therefore were considered perfect adherents to chemotherapy treatment.

3.3. Effectiveness of SMS Support in Chemotherapy Treatment

Although there was no statistically significant association between gender (p = 0.151) and marital status (p = 0.413) with MPR, being female and being married was greatly associated with perfect adherence. Being in low financial status (p = 0.012), lower level of education (p = 0.018), getting enough time during clinic visits (p < 0.001), having enough time with nurses (p = 0.025), and feeling that cancer-related problems were being taken seriously (p = 0.047) were statistically significant in explaining the differences in chemotherapy adherence. Furthermore**,** participants who reported having one regular support person who helped them with routine cancer care were more likely to be perfect adheres, although this difference (p = 0.329) was not statistically significant. Overall, participants who were satisfied with various aspects of health service provision at the chemotherapy treatment center were more likely to be in the perfect adherence group, and these differences were statistically significant. These results are shown in Table 2 and Table 3.

Regarding the effect of the intervention on chemotherapy treatment adherence, the majority, 71.4% (n = 115) of the participants in the perfect adherence group were in the intervention arm of the study, as opposed to 28.6% (n = 46) of perfect adherers who were in the control arm of the study. This difference was statistically significant (p ≤0.001). Furthermore, the majority, 61.2% (n = 178) of participants in the intervention arm of the study, expressed satisfaction with the intervention as opposed to 38.8% (n = 113) of the participants who expressed dissatisfaction with the support of SMS. This result was statistically significant (p = 0.06) as shown in Table 4.

In the GLMM analysis, shown in Table 5, gender was not statistically significant in explaining adherence to chemotherapy, although female participants were 0.7 times more likely to adhere to chemotherapy than male participants (t = −1.680, OR = 0.691, p = 0.094, 95% CI = 0.457 - 1.063). Participants who reported promptness in service delivery every time they came for chemotherapy treatment were more than twice as likely to be perfect adherers to chemotherapy treatment. (t = 4.549, OR = 2.865, p ≤ 0.001, 95% CI = 1.1818 - 4.515). This difference was statistically significant. Paradoxically, individuals who reported low

Table 2. Association between MPR and individual variables.

Characteristic	Total N = 404	MPR		χ^2dd	Sig.
		Perfect adherence	Not-perfect adherence		
Gender					
Male	129 (31.9)	58 (36.0)	71(29.2)		
Female	275 (68.1)	103 64.0)	172 (70.8)	2.064	0.151
Financial position					
Low	215 (53.2)	98 (60.9)	117 (48.1)		
Middle	163 (40.3)	58 (36.0)	105 (43.2)		
Upper	26 (6.4)	5 (3.1)	21 (8.6)	8.796	0.012
Marital Status					
Married	305 (75.5)	127 (78.9)	178 (73.3)		
Single	46 (11.4)	15 (9.3)	31 (12.8)		
Other	53 (13.1)	19 (11.8)	34 (13.9)	1.768	0.413
Regular Support					
Yes	340 (84.2)	139 (86.3)	201 (82.7)		
No	64 (15.8)	22 (13.7)	42 (17.3)	0.952	0.329
Education level					
Tertiary	80 (19.8)	26 (16.1)	54 (22.2)		
Secondary	133 (32.9)	45 (28.0)	88 (36.2)		
Primary	191 (47.3)	90 (55.9)	101(41.6)	8.023	0.018

Table 3. Association between MPR and health system-related variables

Characteristic	Total N = 404	MPR		χ^2dd	Sig.
		Perfect adherence	Not-perfect adherence		
Comfort in the doctor's room					
Yes	377 (93.3)	151 (93.8)	226 (93.0)		
No	27 (6.7)	10 (6.2)	17 (7.0)	0.96	0.757
Others overheard my conversation with the doctor.					
Yes	237 (58.7)	111(68.9)	126 (51.9)		
No	167 (41.3)	50 (31.1)	117 (48.1)	11.667	0.001
I was bothered by others overhearing discussions.					
Yes	67 (16.6)	37 (23.0)	30 (12.3)		
No	337 (83.4)	124 (77.0)	213 (87.7)	7.918	0.005
Staff gave me enough time during visits.					
Yes	302 (74.8)	136 (84.5)	166 (68.3)		
No	102 (25.2)	25 (15.5)	77 (31.7)	13.398	<0.001

Continued

Staff involved me in decisions about care.					
Yes.	300 (74.3)	134 (83.2)	166 (68.3)		
No	104 (23.7)	27 (16.8)	77 (31.7)	11.273	0.001
I had enough time to ask the doctors questions.					
Yes	181(44.8)	76 (47.2)	105 (43.2)		
No	223 (55.2)	85 (52.8)	138 (52.7)	0.625	0.246
I had enough time to ask the nurses questions.					
Yes.	270 (66.8)	118 (73.3)	152 (62.6)		
No	134 (33.2)	43 (26.7)	91 (37.4)	5.040	0.025
HCWs attended to my needs promptly.					
Yes.	304 (75.2)	139 (86.3)	165 (67.9)		
No.	100 (24.8)	22 (3.7)	78 (32.1)	17.668	<0.001
I was satisfied with the progress of the treatment.					
Yes.	315 (78.0)	135 (83.9)	180 (74.1)		
No	89 (22.0)	26 (16.1)	65 (21.9)	5.329	0.020
I felt my illness was being correctly managed.					
Yes.	316 (78.2)	134 (83.2)	182 (74.9)		
No	88 (11.8)	27 (16.8)	61(25.1)	3.947	0.047
In this facility, I felt treated like a person.					
Yes.	311(77.0)	131(81.4)	180 (74.1)		
No.	93(33.0)	30 (19.6)	63 (23.9)	2.906	0.088

Table 4. Association between intervention and MPR.

Study arm	Total N = 404	MPR		χ^2dd	Sig.
		Perfect adherence	Not-perfect adherence		
Intervention.	230 (56.9)	115 (71.4)	115 (47.3)		
Control.	174 (43.1)	46 (28.6)	128 (52.7)	22.942	<0.005

financial leeway were twice as likely to be perfect adherers to chemotherapy treatment than those with higher financial leeway. This difference was statistically significant (t = 3.311, OR = 2.240, p = 0.001, 95% CI = 1.388 - 3.616). The random effect included in the model was the intervention, Table 6. The estimated impact of the intervention on adherence was 0.958 with a z score of 1.42 (p = 0.154, 95% CI = 0.242 - 3.791). The z score of 1.42 shows that the adherence of an average participant in the intervention arm was 1.42 standard deviations above the average adherence in the control arm after adjusting for fixed effects in the model. However, this increase is not statistically significant.

Table 5. Fixed effects influencing MPR.

Model term	Coeff.	SE	t	Sig.	Exp.	95% CI	
						Lower	Upper
Intercept	−1.111	0.595	−6.869	0.062	0.329	0.102	1.060
Prompt treatment attendance	1.052	0.231	4.549	<0.001	2.865	1.1818	4.515
Gender (Male)	−0.361	0.215	−1.680	0.094	0.691	0.457	1.063
Low finances	0.807	0.244	3.311	0.001	2.240	1.388	3.616
Experience of privacy	0.493	0.180	2.735	0.007	1.636	1.149	2.332
Care needs were met	0.394	0.193	2.040	0.042	0.604	0.389	0.974
Satisfied with received care	−0.505	0.223	−2.657	0.024	0.604	0.389	0.935
Trusted the caregiver	−1.017	0.504	−2.019	0.044	0.362	0.134	0.974
Private facility	0.945	0.411	−2.303	0.022	0.389	0.173	0.871

Table 6. Random effect influencing MPR.

Random effect	Estimate	SE	z	Sig	Lower	Upper
SMS-Support intervention	0.958	0.672	1.424	0.154	0.242	3.791

4. Discussion

Although there is a wealth of literature on the utility of SMS in adherence in Kenya with promising results in HIV [28], Malaria [29] and cervical cancer screening [30], data on the utility of SMS support in cancer treatment, with emphasis on intravenous chemotherapy are lacking. Generally, the place of SMS in the adherence literature is preserved [31] [32] [33]. The overall 83.0% mean adherence in this trial is mixed compared to literature. Higher than 83.0% levels of adherence to chemotherapy adherence levels [34] [35] [36] [37] as well as lower than 83.0% levels [38] [39]] [40] [41] have been reported. Although the data on the adherence rate in literature is preponderant toward oral chemotherapy, the factors that shape the adherence patterns are similar to those of intravenous chemotherapy.

The low level of chemotherapy adherence in this trial could be related to the low resources available in Kenya to support patients and clinical teams in improving adherence. Despite this finding, chemotherapy treatment seems to have higher levels of adherence than other diseases. This finding must be viewed in context. First, cancer is a more serious disease than Acquired immunodeficiency syndrome (AIDs) [42], and therefore, viewed in Rosentock's [43] lens, the cancer patient is more likely to adhere. Second, the assessment of adherence to Highly Active Antiretroviral Therapy (HAART) [44] [45], and tuberculosis [46] in Kenya has returned adherence levels of less than 80%. Although cancer in Kenya has higher adherence rates than other diseases, this high rate is still low according to the operationalization standards of this trial as well as the goals of cancer care

contemplated in the National Cancer Control Strategy (2023-2027) [47].

Adherence to chemotherapy treatment is complex and is shaped by a multitude of factors. The isolation and translation of a component of the adherence complex into a necessary cause of observed adherence is equally complex. Maximum effects of chemotherapy treatment require the maximization of the dose of chemotherapy delivered as a function of time, using toxicity as a limiting factor to ensure that adequate chemotherapy is present in plasma at all times to kill cancerous cells or inhibit their growth, resulting in disease remission and improved clinical status of the patient [48] [49]. To achieve the appropriate course of treatment, chemotherapy regimens are offered on schedule to allow cells of the body, killed by chemotherapy toxicity, to regenerate [50] (p. 61), often resulting in cancer distress that may negate adherence [8].

A critical intervention in this study was to help participants in the intervention arm acquire cancer survivorship skills necessary to navigate cancer distress. Despite the overall low adherence rates to chemotherapy treatment in this trial, the results show that 71.4% of participants who had perfect adherence were in the intervention group. Furthermore, there was a significant difference in adherence to chemotherapy treatment between the intervention and the control arm (χ^2dd = 22.942, df = 1, $p \leq 0.001$) and a significant mean difference in adherence between the arms at 3.913 (95% CI: 2.632 to 5.193), higher in the intervention arm, with a moderate design effect of 0.60. In multivariate analysis, a participant in the intervention arm had a mean adherence rate of 1.42 standard deviations above the mean adherence rate in the control arm after adjusting for fixed effects. These results show that SMS support had a superior effect on adherence to chemotherapy treatment. The findings on adherence level for this trial and the literature reveal a pattern that is influenced by the setting of the study, the way adherence is measured, the length of treatment, and the attendant comorbidity. A general pattern shows that adherence to chemotherapy is influenced by the ability of health systems to offer the needed care, mapped into the dichotomy of high versus low income settings [51], as well as the duration of treatment [52] [53], with higher adherence levels preponderant in high income countries.

The field of adherence is saturated with data on interventions aimed at influencing adherence, with mixed results. The literature shows that none is sorely effective, actionable or affordable in usual care settings [54]. It has been estimated that medication reminders show absolute observed improvements in adherence of 33%, [55]. Increased adherence in the intervention arm could be related to improved patient efficacy, internal locus control, and improved health literacy because participants in the intervention arm received a text message that contained, in part, self-care strategies for "general" cancer and symptoms related to cancer treatment, which promote self-efficacy. This finding agrees with a quasi-experimental design that investigated the effect of structured education on medication adherence and self-efficacy and reported increased patient medication adherence (66.39 vs. 71.04, $p < 0.05$) in the intervention arm using the me-

dication adherence self-efficacy scale [14]. Similarly, another study to improve medication adherence with an adjuvant aromatase inhibitor in women with breast cancer using SMS reported 72.4% adherence in the SMS group compared to 59.5% adherence in the standard care group with adjusted OR of 1.78 (95% CI 1.04 to 3.05, p = 0.034) [56]. In a single-blind randomized controlled trial comparing EMPOWER-SMS to usual care in supporting women's health outcomes after breast cancer treatment, it was reported that women in the intervention group had better adherence than the control [57]. The utility of mobile technology in cancer care is gaining momentum. The promise of text messages in supporting different domains of patient care, including adherence, agrees with the current trial that text messages have important implications for cancer care [58]. The role of the clinical care team in designing and implementing strategies aimed at improving adherence to chemotherapy treatment has been underscored in the literature, highlighting the choice of multidisciplinary strategies [31] [59]. Although patient education was significant in the current trial, other studies have not demonstrated an impact of interventions on adherence. A German CRT that evaluated the effect of educational materials in enhancing compliance with aromatase inhibitor (AI) therapy in postmenopausal women did not show differences in adherence between arms [36], although the study used self-report, which has attributable biases, especially for patients in a trial, unlike the current study, which used "hard" adherence measures, the patients' chemotherapy receipt register in the medical file.

Although patients taking intravenous chemotherapy will eventually attend the clinic, the impact of not attending treatment as scheduled, therefore, reducing the intensity of chemotherapy doses, has been reported to be associated with a 2.34 hazard of death [35]. Furthermore, an increase in the disease-free survival rate for patients with higher adherence among breast cancer has been reported [60] while the negative consequences of nonadherence to chemotherapy treatment have been documented [61]. Therefore, the findings of this study underscore the need to incorporate strategies that promote adherence to chemotherapy treatment. The results show that SMS support improves patients' understanding of the disease process, promotes self-care, and significantly impacts the adherence to chemotherapy treatment. Increased patient ability to identify and, where possible, manage adverse events related to cancer and its treatment and promote clinic follow-ups allows patients to participate in care and promotes adherence.

Individual characteristics are essential in shaping the psychological and cognitive drivers of adherence to chemotherapy treatment. This study did not find any difference in the influence of age and gender on adherence to chemotherapy treatment. However, there was a preponderance of adherence to the female and younger participants. This finding is consistent with a systematic review that found no differences in adherence rates in relation to age or gender [62]. The influence of increasing age could be explained by the increasing experience of comorbidity, which increases the frailty and toxicity of chemotherapeutic agents

resulting from altered drug biotransformation that deters adherence [63] [64]. It is also possible that there may be a strong correlation between access to family support among younger cancer patients that may be lacking in older cancer patients. Increasing age could also be associated with dependence, decreased financial freedom, and reduced social support, all factors that hinder adherence. However, this finding contrasts with others that found a strong inverse relationship between increasing age and adherence to chemotherapy treatment [65] [66] [67].

While women in many settings are more likely to use health services [68], there is little data to support this observation about adherence to cancer. Lee [69] did not separate the sole influence of gender on adherence, but was able to show the co-influence of financial barriers and gender on adherence, reinforcing the fact that women may have fewer financial resources to attend to their healthcare needs even though they have greater health needs. Although males generally have a higher risk of developing and dying from cancer [6], Kenyan data shows that women have a higher incidence of cancer incidence than men [70]. This observation agrees with this study that found that most of the participants and the majority of perfect adherents were women. Therefore, it can be argued that the observed increase in adherence among women is due to their higher representative numbers in the sample, which is expected.

In this study, a larger proportion of perfect adherers were married. Cancer care is demanding, and social support is necessary to reinforce healthy behavior, adherence to the treatment schedule, and psychological support [71]. A large meta-analysis reported that marital status increased the odds of adherence to treatment by 1.27, reinforcing the significant role that social support mechanisms play in shaping chemotherapy adherence [15]. In Africa, the significance of marital status has been reported [72]. The interplay of marital status and social support seems to favor women in this trial. A microanalysis of marital status reveals that 49% of all women versus 26.5% of all men in this trial were married. This finding implies that a woman is more likely to enjoy social protection and support than a man.

Cancer and its treatment are financially demanding, either from catastrophic health expenditure or from crippling a breadwinner, culminating in financial toxicity [73], which is disproportionately higher in Kenya [74]. This toxicity results in cancer patients changing their expenses and cutting down on other life goals that require money or delay treatment, a consistent finding in this study. Although 100% of the participants in this study relied on NHIF, transport and accommodation costs, additional costs, such as laboratory work and blood transfusions, are not covered, despite the fact that most of the participants rating their financial situation as low. For this reason, a damaging out-of-pocket expenditure is experienced among cancer patients. Financial resources can influence the timelines of initiating chemotherapy treatment. This study found that more than 2/3 of the respondents delayed initiating treatment due to financial

difficulties. This may be due to the requirement by NHIF that any defaulted payment or new member must wait 60 days before the card is active. This negative correlation between finances and adherence has been reported in Nigeria [38] [75].

This trial found that, in general, participants were satisfied with various aspects of the cancer care services of the facilities. Most of the participants reported being involved in care decisions in both arms of the study, with the majority of the participants in the intervention arm reporting a higher proportion of participation in care decisions. The finding is consistent with Kahn [52], who reported that patients who felt less involved in care decision making were less likely to adhere to treatment. The explanation as to why participants in the intervention arm felt more involved in care is complex; one could hypothesize that the information received through the intervention could have encouraged the participant to be more curious and seek clarity about the direction of the care. Having enough time to ask questions and receive answers is essential to improve the patient's understanding of treatment.

Another factor in the healthcare system is unmet care needs. Health care needs are those states of a person that create requirements for a health care intervention [76], putting the person in a state of service that requires, a search for a pairing of conditions and intervention. An unmet need implies that existing treatment is 'not good enough' to shape the trajectory or alleviate cancer symptoms, and therefore patients with unmet needs will have an accelerated deterioration of their quality of life [77].

A significant proportion of patients reported experiencing a lack of privacy in the doctor's consultation rooms. This lack of privacy was reported as the experience of other patients hearing the participant's conversation with the doctor. When patients experience a lack of privacy, they are less likely to initiate a discussion about sensitive health concerns, particularly those related to sexuality, which may result in unmet need care. Cancer and its treatment invariably affect sexual health, and the WHO has issued the competencies needed to manage sexual health matters. Specific to the cancer care context are (Competencies 1 - 3) that require the creation of an environment in which sexual health can be effectively provided; (Competencies 4 - 5) that require the provision of sexual and reproductive education and counseling; and (Competency 6) that require effective assessment and referral of individuals for sexual health concerns [78]. These competencies are based on candid discussions with the health care provider in a confidential manner.

5. Conclusions

The findings show a small proportion of participants with perfect adherence to chemotherapy treatment, even in the face of intervention. This has policy implications for the goals of cancer care in Kenya. Although SMS support was found to influence adherence to chemotherapy treatment, it is evident from the trial

that a concerted effort is required, at both the individual, facility, and policy levels, to make adherence to chemotherapy treatment perfect and therefore help realize the overarching goals of cancer care in Kenya.

The study recommendations are that although there is no difference in gender-related adherence patterns to chemotherapy, designed programs supporting chemotherapy should be geared toward male cancer patients. Further, facilities that provide chemotherapy treatment should ensure patient privacy and trust in the health care provider, identify and meet unmet care needs, and satisfy the cancer patient care needs are central in chemotherapy administration, and lastly, there should be increased utilization of interventions, particularly education, that improve patient literacy in the cancer survivorship journey to promote perfect adherence.

6. Limitations of the Study

In the intuitive sense, it was not possible to determine whether the participants acted on the support messages shared in the study. To overcome this limitation, the research assistants asked participants from time to time to take into consideration all the health education avenues shared with them from center approved sources.

Disclosure Statement

The authors report that there is no conflict of interest in this trial. The authors are only responsible for the content and writing of this article and that there was no sponsoring agency for the design or reporting of the study conduct.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix: Sample Size Calculation

The comparison sample size to show that intervention was superior to the control in improving adherence was calculated as shown below (S. K. Sharma *et al.*, 2020).

$$N = C \times \frac{\pi_1(1-\pi_1)+\pi_2(1-\pi_2)}{(\pi_1-\pi_2)^2} \times DE$$

where;

N = Required sample size in each arm.

C = Critical value for 80 % power (standard value = 7.8) at α = 5% significance level. A significance level refers to the probability of rejecting a true null hypothesis.

π_1 = Estimated rate of chemotherapy treatment adherence in the absence of intervention. The prevalence of adherence to chemotherapy and other chronic disease treatment averages 50% in developed countries (Horne *et al.*, 2019). There is a dearth of data on the prevalence of adherence to chemotherapy in Kenya. This trial adopted a baseline adherence rate of 70% because a 2019 study showed that 29% of cancer patients in KNH had missed scheduled treatment.

π_2 = Adherence achievable as a result of the SMS-Support intervention projected to be 85%.

$\pi_1 - \pi_2$ = The effect size or magnitude of change in adherence resulting from the intervention.

DE = Design effect.

The DE was estimated as $1 + (m - 1)\rho$, where m was cluster size and ρ the Intra - cluster correlation coefficient (ICC). This study proposed an m of 50 and an ICC of 0.05 (Eldridge & Ukoumunne, 2012).

Therefore, the sample size was

$$\left\{7.8 \times \frac{0.7(1-0.7)+0.85(1-0.85)}{(0.70-0.85)^2}\right\} x1 + (50-1)0.05 = 404 \text{ respondents.}$$

Sample size per cluster of the Trial.

Facility	No. of respondents (%)
Kenyatta National Hospital	100 (24.8)
Moi Teaching & Referral Hospital	85 (21.0)
Jaramogi Oginga Odinga Teaching & Referral Hospital	45 (11.1)
Coast General Teaching and Referral Hospital	36 (8.9)
Texas Cancer Center	35 (8.7)
M.P. Shah Hospital	35 (8.7)
Machakos County Referral Hospital	35 (8.7)
Kakamega County General Hospital	33 (8.2)
Total (N)	**401 (100)**