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Original Research Article

A Quasi-experimental study on the effectiveness of primary caregiver social support capacity on self-management practices of clients living with type II diabetes in Machakos county, Kenya

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ABSTRACT

Background: Diabetes is a fast-growing public health emergency, projected to affect 643 million people by 2045. While primary caregiver social support can influence the self-management practices of Type 2 diabetes (T2D) clients, there's often limited capacity to provide it. The study determined the effectiveness of enhanced caregivers' social support capacity on self-management practices of T2D clients in Machakos.
Methods: A six-month quasi-experimental study design that adopted quantitative and qualitative data collection and analysis approaches. Primary caregivers at the Matungulu intervention site were trained on T2D self-management and types of social support, with no intervention conducted at the Masinga control site.
Results: Over 90% of the 227 primary caregivers were female, with a mean age of 43.28, supporting approximately three T2D clients each. Post-intervention, a 27.2% change in capacity to identify all T2D self-management practices was noted compared to a 7.6% change in the control group. The greatest contribution was in the primary caregivers' ability to provide tangible, followed by emotional and informational social support, resulting in a statistically significant improvement in the self-management practices in the intervention site, B=0.140 (95% CI: 0.072, 0.208), t=4.046, p<0.001. Consequently, the difference in blood glucose levels was statistically significant, crude OR=3.213 [95% CI: 2.039, 5.063], p<0.001.
Conclusions: Enhanced capacity to provide social support positively correlates with the T2D clients' self-management practices. Further investigation of factors that hinder the full realization of primary caregiver social support capacity benefits in improving self-management capacities among T2D clients is recommended.

Keywords: Diabetes type 2, Primary caregivers, Social support, Diabetes self-management, Africa

INTRODUCTION

Diabetes is one of the fastest-growing global health emergencies of the 21st century, projected to affect 643 million people with a health expenditure of over one trillion dollars by 2045.[1] It is a chronic condition that occurs when the body cannot produce enough insulin (diabetes type 2, primary caregivers, social support, diabetes self-management, Africa type 1 diabetes) or cannot effectively use the insulin it produces (type 2 diabetes). People in low and middle-income countries face challenges in accessing treatment due to cost barriers and

distances to health facilities, making self-management know-how critical to sustain lifelong treatment for chronic conditions such as diabetes.[2] Additionally, challenges in diabetes type II care and management are compounded by a lack of testing facilities or training among health workers, and where trained, staff turnover remains significantly high, affecting program continuity.[3] The WHO recognizes that varied self-management mechanisms can promote the active participation of people living with chronic illnesses in their health, ultimately leading to improved health outcomes in the general population.[4] In diabetes care, self-management often involves eating a healthy diet, physical activity, self-monitoring of blood glucose, adherence to medicine, healthy coping mechanisms, regular foot care, and ophthalmic examination.[5] Self-management interventions have been modestly effective in improving the glycemic levels of people with diabetes.[6] In sub-Saharan Africa, for example, self-management is poor due to a lack of culturally relevant knowledge, lack of glucometers, and practice of alternative therapies, including misconceptions that diabetes is a curable disease, often resulting in poor health outcomes and increased burden on the health system.[7] Studies on the impact of primary caregiver social support are limited in Kenya, with the few having been cross-sectional and showing mixed results on health and other outcomes for type 2 diabetes clients.[8]

Caregivers can assist patients with chronic disease in self-management and social support to improve decision-making on health-related behaviors and overall health outcomes. Primary caregivers are often family members, relatives, and friends who live close to the client with chronic illness.[9] In most instances, they are neither prepared nor trained in the care process and, therefore, are unprepared to provide tailored care for persons with chronic illnesses.[10] In diabetes-related social support, primary caregivers are expected to provide instrumental (tangible) support, which includes the provision of tangible aid, financial assistance, food preparation, accompaniment to hospital, goods, and services for diabetes care, emotional support, which involves the provision of love, empathy, appreciation, and caring and informational support which encompasses the provision of advice, feedback information, guidance, and suggestions to address the health problems amongst diabetic patients.[11]

Meta-analysis on the role of primary caregivers has consistently shown that social support enhances glycemic control in individuals with type 2 diabetes; however, it's worth noting that only a minority of individuals with diabetes actually receive this support.[12] Emphasis has been laid on the importance of improving the social support capabilities of primary caregivers when developing self-management support programs for clients with chronic illnesses to meet their self-management needs.[13]

In South Africa, for example, a study recommended enhancing primary caregivers' capacity to provide social support that focuses on the needs of older people with diabetes.[14] Understanding the unique capacity needs of adults with type 2 diabetes and their primary caregivers can enhance self-management and diabetes glycemic levels. Unfortunately, most studies showing this association between primary caregiver social support capacity and glycemic levels amongst diabetic patients have been cross-sectional, with most being conducted in high-income countries such as the UK, Australia, and the USA. This limits the ability to conclusively deduce the association between the different variables in low-resource settings. In Africa, for example, evidence on the buffering effect of primary caregiver social support on glycemic outcomes among patients with type 2 diabetes is still minimal.

This quasi-experimental study, conducted in Machakos County, Kenya, aimed to determine the relationship between primary caregiver social support capacities, self-management practices, and glycemic control among individuals with diabetes. The capacities of interest were knowledge of diabetes self-management practices and the primary caregiver's ability to provide tangible, informational, emotional, and social support to the client with Type 2 diabetes. The study sought to quantitatively and qualitatively assess the influence of enhanced primary caregiver social support capacity on the self-management behaviors of diabetes clients in the same region. Machakos County has nine counties, two of which were selected for the study. The county has one Diabetes Center of Excellence, including level 4 and level 3 health facilities that provide diabetes care services. The lack of diabetes specialists is one of the significant challenges negatively affecting the provision of diabetes care services.

METHODS

Objective

The objective of this study was to assess the comparative effectiveness of improved primary caregiver social support capacity on self-management practices of type II diabetes (T2D) clients in Machakos County, Kenya.

Specific objectives

The objectiveS of this study were to (a) determine the social support capacity of primary caregivers of T2D clients in Machakos county; (b) assess the contribution of capacity strengthening efforts in improving social support capacity; and (c) determine how this influences self-management practices of T2D clients in Machakos County.

Study null hypothesis

No

Primary caregiver social support capacity is not associated with self-management practices of clients living with T2D in Machakos county.

Study alternate hypothesis (H1)

Primary caregiver social support capacity is associated with improved self-management practices of clients living with T2D in Machakos county.

Study design

The study employed a quasi-experimental design that adopted quantitative and qualitative data collection and analysis approaches. The County Health Management Team (CHMT) and health workforce in Matungulu (experimental site) and Masinga (control site) sub-counties helped identify health facilities providing T2D health services and clients diagnosed with T2D from the health facility records.

Study area

The study was conducted between January to June 2023 in Matungulu sub-county, the experimental site, and Masinga sub-county, the control site, both rural sub-counties in Machakos County, Kenya. The county has a population of 1,488,000, per the 2023 Kenya Economic Survey.[15] Data from the Kenya Master Health Facility List 2020 revealed that the county has 416 health facilities, with 6% offering health services to reverse the rising burden of non-communicable conditions.[16] The county has been reported amongst the top counties of the former Eastern province, reporting elevated glucose levels.

Study participants

Clients diagnosed with T2D and enrolled in government-owned public health facility diabetes care and treatment programs in the Masinga and Matungulu sub-counties, between 18 and 65 years of age, who could read and write and who lived with or near a person above 18 years who could serve as a primary caregiver were enrolled in the study. The T2D clients and primary caregivers who did not meet the inclusion criteria, failed to give consent to participate in the study, were of unsound mind, or refused to be followed up were excluded. Identifying study respondents from the health facility had the advantage of a physician-confirmed diagnosis of T2D clients. The T2D clients identified the primary caregivers, who included family members, relatives, and friends who lived in the same household or close to the diabetic patient. The relationship between social support capacity and self-management practices was assessed from the clients' and the primary caregivers' perspectives.

Study intervention

The intervention conducted at the experimental site included training primary caregivers on the basics of T2D, diabetes self-management practices, different types of social support, and how to provide this support to the clients continuously. Additionally, the primary caregiver and T2D clients were supported in developing and implementing a diabetes care plan through monthly household visits for six months. The primary caregiver was also paired with a health worker for additional and continuous support throughout the study. No intervention was carried out at the control site. A pre-test was conducted for both groups before the study rollout, followed by the six-month intervention and a post-test after a six-month implementation period to determine the contribution made by the intervention on adherence to self-management for the clients living with T2D.

Study variables

The independent variables in the study included the primary caregivers' tangible, informational and emotional social support capacity. The study also captured contextual factors such as patient demographic characteristics as independent variables. The dependent variables were self-management practices and glycaemic control outcomes, measured using a random blood sugar test by a health worker before and after the six months of the study period at the health facility.

Data sources

A total caseload of 2,171 clients, 74% female (1596) and 26% male (575), with complete health records enrolled in health facilities offering T2D health services in the two sub-counties, were identified, forming the sampling frame for each sub-county. The gender representation in the study was representative of the trends observed in Machakos County, where more female clients were accessing T2D care and treatment services compared to male clients. Data was collected through two semi-structured questionnaires formatted on the Open Data Kit (ODK). One of the questionnaires targeted clients living with T2D and captured the demographic characteristics of the study group, such as age, education levels, efficacy in T2D self-management, and extent of perceived social support being received by the T2D client. The second semi-structured questionnaire captured the demographic characteristics of the primary caregivers, knowledge levels of diabetes self-management practices, and additional support required to improve social support provision.

Data collection

Twenty research assistants with college-level education who owned Android-supported SMART mobile devices from the two localities were identified, recruited, and trained on the scope of the study and data collection procedures. The research assistants collected the data from the T2D clients and their caregivers at the beginning and the end of the six months in the two study sites. Additionally, Key Informant Interviews (KIIs) were conducted with the non-communicable disease (NCD) coordinators at the county and sub-county levels, including the heads of the NCD clinics in the respective hospitals in the two sub-counties. In total, 20 KIIs were conducted. Focus group discussions were also conducted with the

caregivers to gather information on the quality of social support provided to T2D clients at the study sites. Random Blood Glucose (RBG) tests on capillary blood were performed by the nurse or clinical officer using a standard glucometer at the health facility where the T2D clients accessed their diabetes care during the NCD clinic days. The RBG test was employed to monitor blood sugar levels among T2D clients, which is standard practice in most rural public health facilities in Kenya.

Bias

The 'Hawthorne effect,' which is the tendency of individuals under observation to alter their actions or behaviors simply because they are aware that they are being monitored or studied, could potentially have impacted the findings. In addressing this potential bias, the researcher took time to immerse in the social setting to gain the trust and make both the T2D clients and primary caregivers feel relaxed and unthreatened, thereby becoming accustomed to the presence of researchers or observers over time, to potentially reduce the novelty effect that could initially drive behavior change.

Sample size determination

The appropriate sample size was determined by considering the study power, the confidence interval, and the desired effect size.[17] The study power was set at 80%, the confidence interval at 95%, and the effect size at 10%. A previous study on self-management among patients with type 2 diabetes reported a glycemic control of 36.9%, attributable to self-management practices.[18] In designing this study, the researcher considered a 10% improvement in glycemic control as a suitable effect size attributable to intervention according to the guidance stipulated in the study referenced above.

Below is the expression of the formula for the sample size as used in quasi-experimental study designs.

$$N = \frac{2[Z_{\left(\frac{\propto}{2}\right)} + Z_{(\beta)}]^2[P(1-P)}{(p_1 - p_2)^2}$$

Where;

$$Z_{\left(\frac{\propto}{2}\right)} = 1.96 \begin{pmatrix} \text{standard normal variate for 95\%} \\ \text{confidence interval at type 1 error} \end{pmatrix}$$

$$Z_{(\beta)} = 0.8484\ (standard\ normal\ variate\ for\ 80\%\ power\ at\ type\ 2\ error)$$

$p_1 - p_2$ =10% (Difference in proportion of events in two groups, i.e., effect size)

P = Pooled prevalence= [prevalence in case group (p_1) + prevalence in control group (p_2)]/2=(0.469+0.369)/2=0.419; Based on the figures reported in the referenced study whereby glycemic control attributable to self-management was at 36.9% among T2D patients.

Therefore;

$$N = \frac{2(1.96+0.84)^2 0.419(1-0.419)}{(0.469-0.369)^2} = \frac{15.68 \times 0.243439}{0.01} = 382$$

Hence, the minimum required sample size was 382 eligible diabetic patients for each study site.

A preliminary investigation at Masinga Sub-county and Matungulu Sub-county revealed that every primary caregiver attends to about 3 T2D clients. As such, the minimum sample size for the primary caregivers was given using the following formula:

$$N = 127.333 = 128$$

Therefore, the minimum sample size for primary caregivers was 128 each for the control and intervention sites. During sampling, the clients with complete records were extracted from the client register, coded, and loaded on a 'Research randomizer' digital randomization software for sampling. A sampling interval of 'three' was applied to meet the targeted sample size from the complete sampling frame. The identified T2D respondents were invited to consent to the study. For confidentiality purposes, the patient records were extracted from the hospital records without personal identifiers like names. The identified T2D respondents were then requested to bring their primary caregivers during their clinic days.

Primary caregiver social support capacities

Primary caregivers at the intervention site were trained on diabetes basics, self-management practices, and types of social support

The self-management practices included monitoring blood glucose monitoring, medication management, healthy eating, physical activity, and coping with the psychosocial challenges associated with living with diabetes. The study investigated these capacities through Likert scale questions for clients living with T2D and primary caregivers. The social support training covered three main constructs: emotional, informational, and tangible social support. The extent of perceived social support was measured using a Likert scale on the two semi-structured questionnaires for T2D clients and primary caregivers.

Data processing and analysis

The collected data were exported in Microsoft Excel version 2019, where they were further cleaned and entered into SPSS version 25 for analysis. Descriptive statistics

such as frequencies were used for categorical data, while mean and standard deviations were computed for continuous variables. Levene's test of homogeneity of variance was used for continuous variables, i.e., age and blood glucose readings. Inferential statistical measures, such as the Chi-square test, were used to test the difference in the distribution of parameters for baseline and follow-up data, i.e., test of homogeneity of proportions. Unpaired samples t-test was used to compare means for continuous data for baseline and follow-up scenarios. Likert scale data were subjected to scale reliability analysis using Cronbach's alpha. The difference in difference analysis was made to estimate the significance and effect size attributable to intervention for differences in blood sugar readings and the extent of social support given and received.

Logistic regression was done to explore the predictors of improvement in glycemic control among the T2D clients. Both unadjusted and adjusted odds ratios were reported with their 95% confidence interval lower bound and upper bounds. For the PCGs, case-control matching was done to eliminate case-control bias when running the difference in differences analysis for the extent of social support given.

All hypotheses were tested at a 95% confidence interval; p values of less than 0.05 were considered statistically significant, hence the rejection of the null hypothesis. Cronbach's alpha was used to assess the scales used in the study, whereby $\alpha \leq 0.5$= unacceptable, $\alpha > 0.5$=poor, $\alpha \geq 0.6$=acceptable, $\alpha \geq 0.7$=good, $\alpha \geq 0.9$ excellent.[25] The self-management scale had a Cronbach alpha of 0.63. Cohen's f was used to compute the effect size of the intervention, whereby $f \leq 0.1$=negligible, $f > 0.1$=small, $f > 0.3$=medium, and $f > 0.5$=large effect size. The effect size helped determine the magnitude of the difference in the impact of the intervention between the control and intervention groups. Qualitative data was audio-recorded and transcribed into text. Thereafter, it was thematically coded and analyzed to facilitate theme development. The qualitative information has been used to triangulate the quantitative findings of this study.

RESULTS

Socio-demographic information

Out of the targeted sample size of 128 primary caregivers (PCGs), 138 and 137 PCGs were recruited during the baseline data collection in Masinga Sub-county (control) and Matungulu Sub-county (intervention), respectively, resulting in 107.8% and 107.0% study enrolment rates, respectively. By the end of the study, 114 and 113 study participants were in the control and intervention groups, respectively, resulting in 89.1% and 88.3% retention rates in the control and intervention groups, respectively, against the targeted sample size (Table 1).

The majority of the PCGs (over 90%) were friends or relatives, with most of them being female PCGs compared to males - 119 (86.2%) at baseline and 130 (94.9%) during follow-up in the control group, 130 (94.9%) and 93 (82.3%) during follow-up in the intervention group. The mean age of the PCGs was 43.28 (SD=14.00) years for baseline and 47.92 (SD=11.72) years during follow-up in the control group, while it was 43.31 (SD=13.95) years for baseline and 47.65 (SD=11.63) years during follow-up in the intervention group.

The minimum and maximum ages for the PCGs were 18 years and 83 years, respectively. Regarding their education status, the majority of the study participants had attained secondary education -110 (79.7%) at baseline and 64 (56.1%) during follow-up in the control group, 108 (78.8%) at baseline, and 64 (56.6) during follow-up in the intervention group. Concerning employment status, most of the PCGs were self-employed- 67 (48.6%) at baseline and 57 (50.0%) during follow-up in the control group, 65 (47.4%) at baseline, and 62 (54.9) during follow-up in the intervention group. The majority of the PCGs were Christians across the study groups - 130 (94.2%) at baseline and 114 (100.0%) during follow-up in the control group, 129 (94.2%) at baseline, and 113 (100.0%) during follow-up in the intervention group. By marriage status, most of the PCGs were married - 124 (89.9%) at baseline and 102 (89.5%) during follow-up in the control group, 122 (89.1%) at baseline, and 101 (89.4%) during follow-up in the intervention group. Throughout the study sites, most of the PCGs report having more than three people older than 18 years living in their households - 88 (63.8%) at baseline and 52 (45.6%) during follow-up in the control group; 84 (61.3%) at baseline and 51 (45.1%) during follow-up in the intervention group. Table 1 summarizes the distribution of the primary caregivers by sex, level of education, employment status, religion, marital status, adults in the household, relationship with the diabetic person, and duration of time they had been involved in caring for the T2D clients.

Social support capacity of primary caregivers

When assessed on their knowledge of T2D self-management practices, such as conducting regular physical exercise, eating a proper diet, keeping stress levels low, taking regular blood sugar tests, making hospital visits as required, and taking diabetes medication as required, a change of knowledge levels by 27.2% from pre to post-intervention in the intervention group was observed, with more primary caregivers in the intervention group able to identify all the diabetes self-management strategies after the training. Table 2 summarizes the distribution of knowledge levels on the different T2D self-management practices before and after the follow-up period among the PCGs in the control and intervention groups.

A statistical analysis was also made on the social support capacity of the PCGs pre and post-intervention. The difference in the mean score for the level of emotional support provided by the primary caregivers was higher in the intervention group (0.87) than in the control group

(0.49). This pattern was similar for informational support (intervention group mean=0.70, control mean=0.54) and tangible support (intervention group mean=0.72, control mean=0.19). Overall, the extent of social support the primary caregivers provided significantly improved post-intervention in the intervention group (0.76) compared to their control counterparts (0.41). The difference in differences in means from Table 3 showed that the most significant impact of the intervention was on the primary caregivers' capacity to provide tangible support (0.53), followed by emotional support (0.38) and informational support (0.16). Further analysis with simple linear regression showed that the observed difference was statistically significant at 95% confidence interval, B=0.356 (95% CI: 0.086, 0.627), t=2.586, p=0.01, R2=0.137. The effect size was determined to be medium, Cohen's f=0.40, implying that the intervention considerably affected the primary caregivers' capacity to provide social support to the T2D client. After performing a case-control matching on age and sex for the primary caregivers to eliminate any case-control bias due to the differences observed between the control and intervention groups, the difference in the mean score for social support between the intervention group and the control group improved, B=0.399 (95% CI: 0.108, 0.69), t=2.694, p=0.007, R2=0.160. After case-control matching, the effect size improved from medium to large, with Cohen's f=0.44. This implies that the training played a major role in improving the capacity to provide social support for the primary caregivers in the intervention group.

The PCGs further identified sixteen areas of support required to facilitate optimal social support to their T2D clients. Areas of support most needed included the need for training to understand diabetes management, support in the development of a diabetes care plan, provision of resources to meet dietary and medication requirements, linking with a health worker, supply of glucometers for regular blood sugar monitoring and protective equipment such as umbrellas and gumboots for the home visits. Following the intervention at the intervention site, a significant reduction in the number of PCGs requiring support in training (24.3%), development of a care plan (32.1%), and linking with a health worker was noted (51.6%), implying improved capacity to manage their T2D clients without external support. There was also an increase in primary caregivers appreciating the need for glucometers to support their T2D clients in blood sugar monitoring (31.9%) amongst the intervention group. 71.1% of PCGs in the control site still required to be linked with the health worker to consult when they needed information on diabetes compared to 5.3% of PCGs in the intervention group by the end of the study, implying increased confidence levels amongst the PCGs in the intervention sites to provide social support to their T2D clients.

Results from the qualitative data gathered through focus group discussions and key informant interviews were transcribed and themed. From the analysis, it was clear that little investment had been made to enhance the capacity of primary caregivers to care for T2D clients. Most effort, if at all, was directed towards the T2D clients. This support included forming T2D client peer support groups where the clients could meet every so often to share their experiences in diabetes self-management. The NCD coordinators revealed that staff shortages were a significant barrier to community-level engagement of both T2D clients and their caregivers. The health workers mainly relied on the irregular monthly visits by the T2D clients to assess self-management practices, monitor blood sugar, and provide guidance on the medication. More often than not, Community Health Workers played the role of primary caregivers and visited the clients during their usual household visits. During these visits, diabetes did not get much priority since most priority is given to reproductive health issues, such as encouraging pregnant women to attend their Antenatal clinics or checking the immunization status of children under five.

The effect of improved social support capacity on self-management practices of T2D clients

The 15-item 4-point Likert scale used to assess diabetes self-management practices amongst the T2D clients indicated an improvement in the intervention group compared to the control group (0.10 versus 0.24 difference in differences for the control and intervention groups, respectively). By comparing the mean scores for self-management practices among the T2D clients using unpaired samples t-test, it was noted that almost all self-management scale items underwent statistically significant improvements in the intervention group. In contrast, only a few scale items had significant changes in the control group, as depicted in Table 4. Further, a difference in differences analysis with a multivariable linear regression approach revealed a statistically significant difference in the self-management practices amongst T2D clients attributable to the changes in the social support capacities in the intervention group, as depicted in (Figure 1).

From the analysis, the effect of the intervention on self-management practices with a parallel trends assumption approach. The effect size was large, Cohen's f=0.98, implying that the improved capacity of the primary caregivers had a major effect on the T2D client's ability to self-manage. A further difference in differences analysis with linear regression approach indicated a statistically significant improvement in the self-management practices of the T2D clients in the intervention group compared to the controls, B=0.140 (95% CI: 0.072, 0.208), t=4.046, p<0.001.

Effect of improved social support capacity on blood sugar status

While a 4.9% drop in the proportion of T2D clients with normal blood sugar in the control group was observed, the intervention group experienced an increase in the

proportion of T2D clients with normal blood sugar levels by 18.2%. The proportionality of blood sugar states was also significant in the intervention group based on the Chi square test, $\chi 2$ (2)=34.188, p <0.00, as depicted in Table 5. Further analysis for the difference in differences using linear regression indicated a statistically significant difference in the mean blood glucose levels of the intervention group compared to their control counterparts, B=-2.162 (95% CI: -3.212, -1.113), t=-4.041, p<0.001.

The effect size was small, Cohen's f=0.15. This difference in blood glucose levels between the intervention group and the controls was further illustrated by leveraging the parallel trends assumption, as shown in Figure 2. Additional analysis with logistic regression revealed that the T2D clients in the intervention group were roughly 3 times more likely to have normal blood glucose levels compared to their control group counterparts, and the difference was statistically significant, crude OR=3.213 (95% CI: 2.039, 5.063), p<0.001.

Adjusting for age, sex, education, employment, marital status, duration with diabetes, and the number of adults in the households of the PWDs, the likelihood of having normal blood glucose levels among the participants in the intervention group was roughly 7 times more than their counterparts in the control group though the difference was not statistically significant, adjusted OR=7.504 (95% CI: 0.158, 356.547), p=0.31. The effect size for the crude model was small, Cohen's f=0.24 while that for the adjusted model was large, Cohen's f=0.41. Correlation analysis was conducted to determine the effect of the different kinds of social support on the blood sugar levels of T2D clients observed above. The findings revealed that all types of social support had a positive effect on reducing the blood sugar levels of T2D clients; hence, the negative correlation coefficients were observed.

Stronger correlations were observed in the intervention group compared to the control group for all the types of social support, with tangible support reporting a correlation of -0.23 against -0.04, informational support reporting a correlation of -0.11 against -0.07, and emotional support reporting -0.14 against 0.05 in the intervention and control groups, respectively. Overall, all types of social support were significantly correlated with blood sugar levels, with the strongest correlation being observed on the tangible social support received (r=-0.13, p < 0.001), followed by informational support (r=0.10, p <0.001), and then emotional support (r=0.06, 0.03).

From the qualitative results, there was a recommendation to provide training on diabetes for health workers serving in the diabetes clinics. The lack of commodities and testing equipment at public health facilities is also a major challenge compelling client referrals to private healthcare providers that are often more expensive than the clients can afford. Unfortunately, most of the effort is towards curative health services such as renal centers instead of investment through outreach and community screening to create awareness of T2D and encourage early screening. Whenever Community Health Workers are involved, support is only provided when there's support from development partners, which is unsustainable and affects continuity.

Table 1: Socio-demographic characteristics of the primary caregivers.

Variables and categories	Control (Masinga sub-county) N (%)			Intervention (Matungulu sub-county) N (%)		
	Baseline (n=138)	Follow-up (n=114)	P value[a]	Baseline (n=137)	Follow-up (n=113)	P value[a]
Sex						
Male	19 (13.8)	22 (19.3)	0.24	7 (5.1)	20 (17.7)	0.001*
Female	119 (86.2)	92 (80.7)		130 (94.9)	93 (82.3)	
Age (years)						
≤45	87 (63.0)	54 (47.4)	0.01*	87 (63.5)	54 (47.8)	0.01*
>45	51 (37.0)	60 (52.6)		50 (36.5)	59 (52.2)	
Mean (SD)	43.28 (14.00)	47.92 (11.72)	0.005*[b]	43.31 (13.95)	47.65 (11.63)	0.01*[b]
Highest level of education						
Primary	22 (15.9)	28 (24.6)	<0.001*	21 (15.3)	28 (24.8)	<0.001*
Secondary	110 (79.7)	64 (56.1)		108 (78.8)	64 (56.6)	
College	6 (4.3)	22 (19.3)	8 (5.8)	21 (18.6)		
Employment status						
Unemployed	46 (33.3)	38 (33.3)	0.95	45 (32.8)	18 (15.9)	0.007*
Self-employed	67 (48.6)	57 (50.0)		65 (47.4)	62 (54.9)	
Employed	25 (18.1)	19 (16.7)		27 (19.7)	33 (29.2)	
Marital status						
Single	3 (2.2)	4 (3.5)	0.25	4 (2.9)	4 (3.5)	0.29
Married	124 (89.9)	102 (89.5)		122 (89.1)	101 (89.4)	
Divorced/separated	4 (2.9)	0 (0.0)	4 (2.9)	0 (0.0)		
Widowed	7 (5.1)	8 (7.0)	7 (5.1)	8 (7.1)		

Continued.

Variables and categories	Control (Masinga sub-county) N (%)			Intervention (Matungulu sub-county) N (%)		
	Baseline (n=138)	Follow-up (n=114)	P value[a]	Baseline (n=137)	Follow-up (n=113)	P value[a]
People older than 18 years living in the participant's household						
None	0 (0.0)	0 (0.0)	<0.001*	0 (0.0)	0 (0.0)	<0.001*
1 person	4 (2.9)	4 (3.5)		3 (2.2)	1 (0.9)	
2 people	35 (25.4)	18 (15.8)		39 (28.5)	21 (18.6)	
3 people	11 (8.0)	40 (35.1)		11 (8.0)	40 (35.4)	
>3 people	88 (63.8)	52 (45.6)		84 (61.3)	51 (45.1)	
Mean (SD)	3.93 (1.69)	3.55 (1.60)	0.07[b]	3.84	3.54	0.15[b]
What is your relationship with the person living with diabetes?						
CHW	0 (0.0)	4 (3.5)	<0.001*	0 (0.0)	4 (3.5)	<0.001*
Friends	8 (5.8)	0 (0.0)		8 (5.8)	0 (0.0)	
Neighbor	67 (48.6)	48 (42.1)		63 (46.0)	48 (42.5)	
Relative	44 (31.9)	62 (54.4)		48 (35.0)	61 (54.0)	
Spouse	19 (13.8)	0 (0.0)		18 (13.1)	0 (0.0)	

Note: a- Chi-square test unless indicated otherwise; *statistically significant at 95% confidence interval; b- Unpaired samples t-test; c- Levene's F-test; SD- standard deviation.

Table 2: Knowledge levels of self-management practices by primary caregivers.

Diabetes self- management strategies	Control (Masinga sub-county) N (%)			Intervention (Matungulu sub-county) N (%)		
	Baseline (n=138)	Follow-up (n=114)	P value[a]	Baseline (n=137)	Follow-up (n=113)	P value[a]
Conducting regular physical exercise	14 (10.1)	51 (45.9)	<0.001*	15 (10.9)	27 (23.9)	<0.001*
Eating a proper diet	15 (10.9)	73 (65.8)		20 (14.6)	35 (31.0)	
Keeping low stress levels	0 (0.0)	44 (39.6)		8 (5.8)	31 (27.4)	
Taking regular blood sugar tests	1 (0.7)	52 (46.8)		4 (2.9)	27 (23.9)	
Hospital visits as required	18 (13.0)	43 (38.7)		28 (20.4)	33 (29.2)	
Taking diabetes medication as required	63 (45.7)	55 (49.5)		44 (32.1)	33 (29.2)	
All the above	28 (20.3)	31 (27.9)		50 (36.5)	72 (63.7)	
Total	138 (100.0)	110 (100.0)		137 (100.0)	113 (100.0)	

Note: a- Chi-square test; *Statistically significant at 95% confidence interval.

Table 3: Extent of social support provided by primary caregivers.

Variable and categories	Control (Masinga Sub-County) N (%)			Intervention (Matungulu Sub-County) N (%)		
	Baseline (n=138)	Follow-up (n=114)	P value[a]	Baseline (n=137)	Follow-up (n=113)	P value[a]
Emotional support						
Overall mean (SD)	3.68 (1.16)	4.17 (0.60)	0.001*	3.43 (1.08)	4.30 (0.52)	<0.001*
Diff in means[b]	0.49		N/A	0.87		N/A
Did in means[c]	0.38					
Informational support						
Overall mean (SD)	3.75 (1.28)	4.29 (0.50)	<0.001*	3.71 (1.17)	4.41 (0.39)	<0.001*
Difference in means[b]	0.54		N/A	0.70		N/A
Did in means[c]	0.16					
Tangible support						
Overall mean (SD)	3.07 (1.11)	3.26 (0.68)	0.001*	3.00 (0.99)	3.73 (0.61)	<0.001*
Difference in means[b]	0.19		N/A	0.72		N/A
Did in means[c]	0.53					
Overall social support						
Mean (SD)	3.50 (1.04)	3.91 (0.36)	0.03*	3.38 (0.94)	4.15 (0.30)	<0.001*
Difference in means[b]	0.41			0.76		

Note: *-Statistically significant at 95% confidence interval; a-Unpaired samples t-test; SD, standard deviation; b-difference in means was calculated as post-intervention mean minus pre-intervention mean; N/A, not applicable; cDiD- difference in differences, Means computed from Likert scale scoring: 'None of the time'=1; 'A little of the time'=2; 'Some of the time'=3; 'Most of the time'=4; 'All the time'=5.

Table 4: Self-management practices of type 2 diabetes clients.

Variable and categories	Control (Masinga sub-county) N (%)			Intervention (Matungulu sub-county) N (%)		
	Baseline (n=324)	Follow-up (n=337)	P value[a]	Baseline (n=402)	Follow-up (n=403)	P value[a]
1. I check my blood sugar levels with care and attention						
Mean (SD)	2.67 (1.06)	2.85 (1.07)	0.03*	3.34 (0.92)	3.70 (0.57)	<0.001*[b]
2. The food I choose to eat makes it easy to achieve optimal blood sugar levels						
Mean (SD)	3.13 (0.91)	3.45 (0.82)	<0.001*	3.00 (0.81)	3.44 (0.76)	<0.001*[b]
3. I keep all doctors' appointments recommended for my diabetes						
Mean (SD)	3.63 (0.75)	3.64 (0.70)	0.84	3.25 (0.92)	3.65 (0.64)	<0.001*[b]
4. I take my diabetes medication (e.g. insulin, tablets) as prescribed, e.g. insulin, tablets) as prescribed						
Mean (SD)	3.56 (0.86)	3.65 (0.74)	0.14	3.45 (0.84)	3.74 (0.50)	<0.001*[b]
5. Occasionally I eat lots of sweets and other foods rich in carbohydrates						
Mean (SD)	1.67 (1.11)	1.69 (1.06)	0.80	1.55 (0.90)	3.05 (1.16)	<0.001*[b]
6. I record my blood sugar levels regularly to monitor my blood sugar levels						
Mean (SD)	2.39 (1.21)	2.66 (1.24)	0.005*	2.37 (0.93)	2.58 (0.95)	0.002*[b]
7. I tend to avoid diabetes-related hospital visits						
Mean (SD)	1.78 (1.17)	1.83 (1.20)	0.56	1.39 (0.81)	1.27 (0.66)	0.02*[b]
8. I do regular physical activity to achieve optimal blood sugar levels						
Mean (SD)	3.11 (0.94)	3.26 (0.97)	0.05	2.87 (0.91)	3.43 (0.82)	<0.001*[b]
9. I strictly follow the dietary recommendations given by my doctor or diabetes specialist						
Mean (SD)	2.70 (0.94)	3.13 (0.97)	<0.001*	2.63 (0.93)	3.30 (0.93)	<0.001*[b]
10. I do not check my blood sugar levels frequently enough to acheive good blood glucose control						
Mean (SD)	2.43 (1.17)	2.18 (1.23)	0.009*	2.15 (1.04)	1.90 (1.01)	0.001*[b]
11. I avoid physical activity although it would improve my diabetes						
Mean (SD)	1.52 (0.83)	1.64 (1.00)	0.10	1.54 (0.85)	1.40 (0.74)	0.01*[b]
12. I tend to forget to take or skip my diabetes medication (e.g. insulin, tablets)						
Mean (SD)	1.57 (1.03)	1.51 (0.99)	0.44	1.40 (0.81)	1.30 (0.68)	0.06[b]
13. I should visit the health facility whenever I suspect a diabetes-related complication						
Mean (SD)	3.46 (0.98)	3.30 (1.15)	0.05	3.43 (0.85)	3.75 (0.63)	<0.001*[b]
14. I tend to skip planned physical activity						
Mean (SD)	1.48 (0.90)	1.51 (0.94)	0.72	1.42 (0.78)	1.20 (0.58)	<0.001*[b]
15. My diabetes self-care is poor						
Mean (SD)	1.50 (0.86)	1.49 (0.93)	0.92	1.90 (1.10)	1.50 (0.83)	<0.001*[b]
Overall mean (SD)	3.07 (0.35)	3.16 (0.37)	0.001*	2.38 (0.34)	2.61 (0.26)	<0.001*[b]
Difference in means[b]	0.10		N/A	0.24		N/A

Note: *-Statistically significant at 95% confidence interval; a-Unpaired samples t-test; SD- standard deviation; b- Difference in means calculated as post-intervention mean minus pre-intervention mean. Likert scale scoring: 'not at all'=1, 'neutral'=2, 'agree=3, 'strongly agree'=4. When calculating the overall mean score, reverse scoring was done for items no. 7, 10, 11, 12, 14, and 15 since they were negatively worded, whereby, 'not at all'=4, 'meutral'=3, 'agree'=2, 'strongly agree'=1 N/A, not applicable.

Table 5: The distribution of the people living with diabetes by their blood sugar levels.

Blood sugar level (mmol/l)	Control (Masinga sub-county) N (%)			Intervention (Matungulu sub-county) N (%)		
	Baseline (n=324)	Follow-up (n=337)	P value[a]	Baseline (n=402)	Follow-up (n=403)	P value[a]
Low	6 (1.9)	14 (4.2)	0.15	12 (3.0)	7 (1.7)	<0.001*
Normal	210 (64.8)	202 (59.9)		258 (64.2)	332 (82.4)	
High	108 (33.3)	121 (35.9)		132 (32.8)	64 (15.9)	
Total	324 (100.0)	337 (100.0)		402 (100.0)	403 (100.0)	
Variance	26.30	32.69	0.02*[c]	33.44	12.63	<0.001*[c]
Mean (SD)	10.29 (5.13)	10.55 (5.72)	0.55[b]	10.84 (5.78)	8.93 (3.55)	<0.001*[b]
Difference in means[c]	0.26		N/A	-1.91		N/A

Note: a- Chi-square test unless indicated otherwise; *- statistically significant at 95% confidence interval; b- unpaired samples t-test; c- Levene's F-test; N/A, not applicable, SD- standard deviation; c-difference in means was calculated as post-intervention mean minus pre-intervention mean.

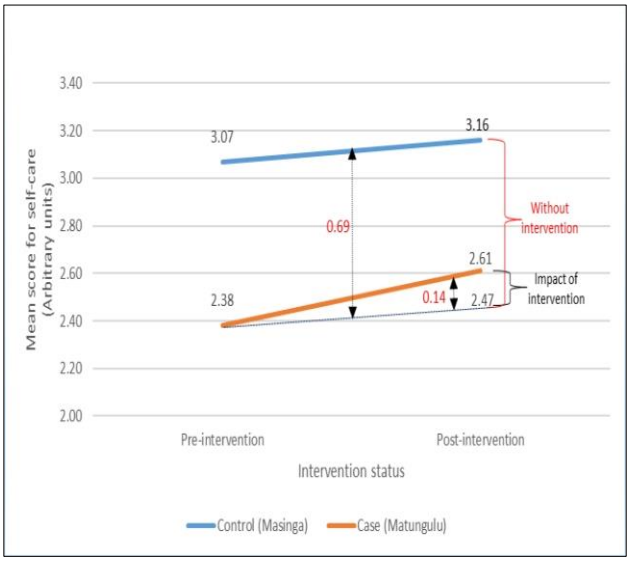

Figure 1: Difference in differences of the mean score for self-care management practices among T2D clients.

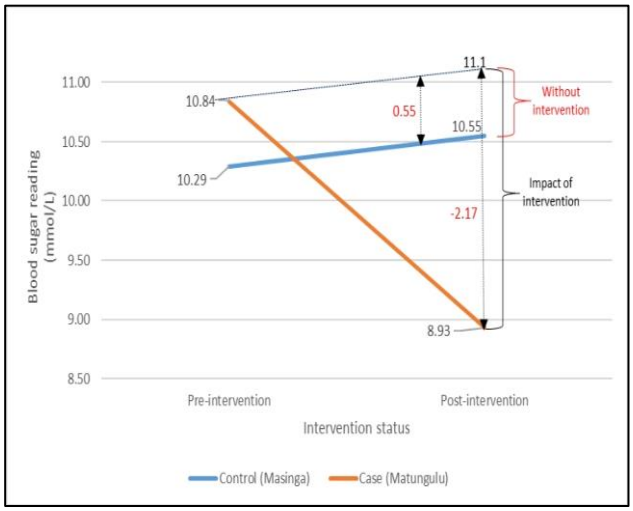

Figure 2: Blood sugar readings pre and post-intervention for T2D clients living in control and intervention sites.

DISCUSSION

The study, conducted over six months, showed a retention of over 80% of study respondents, considered high or acceptable for community-based health research.[19] Each primary caregiver identified could support approximately three T2D clients in the respective sites, while initial assumptions provided a 1:1 T2D client primary caregiver ratio. This was mainly due to the 'shared care model' facilitated by, among other things, the cultural responsibility observed in most African settings where the extended family system, usually a generation of three or more families, co-habit in the same homestead and play vital roles in providing active care voluntarily in caring for their elderly and sick.[20] The success of this model is dependent on the availability of extended family members or social interconnectedness due to the sense of cultural responsibility in the provision of care.

Since including caregiver information is not a standard protocol in patient health records, the study relied on the T2D clients to identify their primary caregivers. This situation was not always straightforward and was challenging for several reasons. Some T2D clients did not identify or recognize family members as caregivers, and where interviews were conducted in the households, family members did not self-identify as caregivers because 'caregiving' is more often than not viewed as a natural responsibility amongst adult family members.[21] This could be partly because of the way Chronic care models (CCMs) are structured more often than not, giving prominence to the role of the T2D clients and the health care provider in defining priorities in T2D self-management, developing care plans, and monitoring results for self-care, with little or no mention of the role of the primary caregiver in improving self-management practices of T2D clients.[22] Formal integration and recognition of the role of primary caregivers in community chronic care models could have several advantages, including structured capacity strengthening for primary caregivers, formalized access to health providers for health information, and communication to improve social support to T2D clients, including access to resources and enhanced trust with the health system.[23]

As has been the case in other studies, over 80% of the primary caregivers in this study were female relatives or neighbors who sometimes doubled up as community health workers in the respective study sites.[24] This finding aligned with previous studies that reported that 57-81% of caregivers are women, mainly wives or adult daughters, compelled to take on the role due to a complex mix of expectation and obligation.[25] A large body of evidence has revealed that female caregivers suffer more from the negative

consequences of providing care and have greater exposure to caregiving stressors with minimal empirical support for the journey. Separate studies have also revealed that these stressors sometimes discourage caregivers from continuing with caregiving.[26] To improve the quality of social support, primary caregivers need to safeguard their well-being, enhance their capacity to provide social support in chronic care and develop coping strategies through peer support, mentorship, and socialization opportunities.[27] There's, therefore, a need to explore approaches that could link female caregivers to community resources such as community organizations and peer support groups for experience sharing and learning to motivate and sustain the provision of social support to T2D clients.

Over half of these had secondary education with a stable source of income (66.7% in the control group and 84.1% in the intervention group) through formal or self-

employment, a situation that could de-emphasize the 'shared' extended family living environment following the financial independence that a source of income presents.[28] In some instances, low literacy levels of primary caregivers affect the ability to provide adequate social support, which could interfere with intended health outcomes.[29] A negative correlation between the caregivers' level of education and the burden of care score has also been reported, implying that the education level of the primary caregiver greatly contributes to their ability to handle stressful situations during caregiving.[30] There's, therefore, an urgent need to support education infrastructure in countries not just for economic reasons but also as a public health concern since every single person living long enough will likely take on the role of a primary caregiver or need a family caregiver, or both. As revealed from the qualitative data, low education levels can be complemented by health literacy programs for the primary care givers through integrated health outreaches at the community.

Given the dynamic nature of T2D, primary caregivers need sufficient knowledge and skills in diabetes self-management to provide optimal social support to T2D clients. T2D clients consider self-management social support adequate when they receive timely tangible, informational, and emotional social support.[31]

A meta-analytic review of 122 empirical studies has also previously reported that adherence to self-management practices of T2D clients was 27% higher when patients had social support available.[32] Education of primary caregivers on diabetes self-management practices such as physical exercise, blood sugar monitoring, diabetic medication, meal planning, etc., and other social support needs of T2D clients has been shown to improve diabetes self-management and, ultimately, glycemic control amongst their T2D clients.[32] This study examined the primary caregivers' social support capacity to determine their ability to influence self-management practices and, ultimately, glycemic control among T2D clients. Following training and continuous follow-up of primary caregivers in the intervention site, a 27.2% change in knowledge levels on T2D self-management practices from pre-intervention (36.5%) to post-intervention (63.7%) was noted among the primary caregivers in the intervention group compared to a 7.6% improvement in the control group, with a statistically significant difference in the self-management practices of T2D clients at the intervention site attributable to the changes in the social support capacities in the intervention group.

Consequently, improved social support significantly correlated with blood sugar levels in the intervention group, with the strongest correlation being observed on the tangible social support received, followed by informational and emotional support. This implies that diabetes self-management education (DSME) for primary caregivers can be a valuable approach to improving diabetes self-management amongst T2D clients and, ultimately, glycemic control. This finding is aligned with a systematic review that found evidence that DSME of primary caregivers improved self-management behaviors and health outcomes among uncontrolled glycemia T2D patients.[33]

That said, linkages between health systems and communities remain critical and may leverage community resources such as primary caregivers to address unmet needs of chronically ill patients in home-based care and provide services for improved continuity and coordination of care for persons living with chronic illnesses such as T2D. As was noted amongst primary caregivers in the control group, there was still a dire need for linkages with community health workers (71.1%) and health workers (71.9) post-intervention for information on how best to support their clients post-intervention. This implies that the link, strength of relationships, and communications between health workers in the formal health system and caregivers and patients are critical components of the expanded Chronic Care Model, making it essential to ensure adequate staffing levels and competency amongst health workers to improve health literacy of both caregiver and T2D clients.[34]

The ability of the primary caregivers to adequately support the T2D clients' self-management, even with the requisite training, is multi-dimensional. It may be hampered by a myriad of factors, including personal characteristics, their health status, availability of resources to meet the needs of the T2D client, environmental characteristics, and other healthcare system factors.[43]

As reported by the primary caregivers, these factors include resources to meet dietary (96.5%) and medication (89.4) requirements, provision of protective equipment such as umbrellas and gumboots for use during home visits (75.2%), and supply of glucometers (53.1%) for continuous blood sugar monitoring for the T2D clients. Limited personal and household financial resources to meet care demands can increase the risk for adverse outcomes, such as distress for the caregiver and T2D client, especially if there are substantial out-of-pocket costs to meet care needs. Additional investment and holistic support are required to address the dynamic interplay of factors that hinder the full realization of the benefits of enhanced social support capacity amongst PCGs in improving self-management capacities among T2D clients. Addressing these barriers while developing tailored community-based patient-centered interventions can improve self-management practices and glycemic control amongst T2D clients.[35]

Limitations

The study was also conducted in one county covered by one community in Kenya, implying that cultural biases may have come into play and affect its replicability.

CONCLUSION

The study builds a case for investment in primary caregiver social support programs following the positive association between primary caregiver social support capacity and the ability of T2D clients to self-manage. Most primary caregivers in this and other studies have been reported to be female, calling for further investigation into the influence of gender on outcomes of social support provision and consequently informing the development of gender-specific caregiver interventions. Level of education and health literacy, in this case, knowledge of diabetes self-management practices and social support provision, have also been found to contribute significantly to the ability of primary caregivers to support their T2D clients and consequently influence their self-management practices and glycemic levels. No more than 50% of primary caregivers could identify all self-management practices of T2D clients before the intervention. Wholistic investment in primary caregiver social support capacities cannot be overemphasized. As seen in the study, this intervention resulted in a 27.2% improvement in the ability to identify all self-management practices and consequently positively influence self-management practices amongst T2D clients. A review of Chronic Care Model protocols, especially in low-resource settings, is recommended to ensure the incorporation of evidence-based primary caregiver social support programs to improve self-management practices of T2D clients. The models should include incentives for healthcare systems to incorporate primary caregivers into healthcare decision-making for T2D clients. There's also a need to explore approaches that could link caregivers to community resources such as community organizations and peer support groups for experience sharing and learning to motivate and sustain the provision of social support to T2D clients. That said, the burden of provision of social support by primary caregivers of T2D clients is a multi-dimensional issue, influenced by both caregiver and health system factors, some of which can be modified to improve the outcomes of social support for T2D clients. The study noted a dynamic interplay of factors that hinder the full realization of the benefits of enhanced social support capacity amongst primary caregivers in improving self-management capacities among T2D clients, such as the lack of glucometers and protective wear for primary caregivers. Addressing these barriers while developing tailored community-based patient-centered interventions can improve self-management practices and, ultimately, glycemic control amongst T2D clients.

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