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Effect of Mobile Health on Modifying the Behaviouraland Physiological Risk Factors of Non-communicable Diseases in Adult HIV Patients on Antiretroviral Therapy in Fako Division

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Abstract **Background:** Non-communicable diseases (NCDs) have reached epidemic proportion among people living with HIV (PLHIV) and this could have a negative bearing on the quality of life and survival of these patients. The incorporation of a target specially dedicated to NCDs within the goal number 3 of the newly adopted Sustainable Development Goals indicates the importance the world now accords to the prevention and control of these diseases. Mobile phone technology is increasingly viewed as a promising communication channel that can be utilized for primary prevention of NCDs by promoting behavioural changes and risk factor modification. **Aim:** The aim of this study was to determine the effect of mobile Health on modifying the behavioural and physiological risk factors of non-communicable diseases in adult HIV patients on antiretroviral therapy in Fako Division, South West Region of Cameroon. **Methodology:** A non-ramdomised hospital-based control trial was conducted on 275 subjects, over a period of one year. A mHealth intervention package consisting of weekly text messages and monthly telephone calls addressing lifestyle modification for risk factors of NCDs was given to the intervention group, compared to no intervention package in control group. Data was entered in SPSS 25 and analyzed using stata 13. Chi-square test, ANOVA and paired sample t-test were used for the analysis. Statistical significance was set at $p<0.05$. **Results:** The mHealth intervention significantly increased the mean number of fruits/vegetable servings a day (2.5 to 4.2, $p<0.001$), mean physical activity level in MET-min/wk (243.3 to 301.1, $p<0.001$) and the physical domain of quality of life (68.3 to 70.9, $p=0.021$) in the intervention group but not in the control group. This intervention equally significantly decreased the mean BMI (26.4 to 25.7, $p=0.004$) and the SBP (125.4 to 124.0, $p=0.003$) in the intervention but not in the control group. **Conclusion:** Our study has demonstrated the usefulness of mHealth for health promotion and lifestyle modification among adult HIV patients on ART. With the growing burden of NCDs among PLHIV, such cost effective and innovative measures will be needed that can easily reach the masses.

Keywords: *effect, mHealth, behavioural and physiological risk factors, Quality of Life, HIV, ART, Fako Division*

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1. Introduction

The burden of non-communicable diseases (NCD) and their modifiable risk factors is on the rise in Sub-Saharan Africa (SSA). The incorporation of a target specially dedicated to NCDs within the goal 3 of the newly adopted Sustainable Development Goals indicates the importance the world now accords to prevention and control of these diseases. Among people living with HIV (PLHIV), epidemiological studies have revealed a trend of increasing prevalence of four major risk factors of NCDs; hypertension, hyperglycemia, dyslipidemia and obesity [1,2,3]. With the increasing availability of antiretroviral therapy (ART), the ageing HIV population is susceptible to traditional risk factors for NCDs. Furthermore, both the HIV virus and prolonged ART use have been associated with dyslipidemia, insulin

resistance, and atherosclerosis, interacting with traditional risk factors to increase the risk of NCDs among PLHIV [3,4]. The increased NCDs risk among PLWH has the potential to threaten the success of ART use, causing morbidity, poor quality of life and premature mortality.

In Cameroon, the universal test and treat approach was instituted in 2016. This novel approach requires placing all persons testing positive for HIV on ART irrespective of their immunological and clinical statuses. Since the institution of this novel strategy in Cameroon, very few studies have investigated the epidemiology of NCDs among PLHIV in the context of the universal test and treat strategy.

Approximately more than 35 million deaths are caused by non-communicable diseases (NCDs) on an annual basis. Morbidity and mortality due to NCDs contribute significant threat globally on health and economy of individuals, societies and health systems [5,6]. The four main NCDs which are being targeted for control globally are cardiovascular diseases (CVDs), chronic respiratory diseases, cancers and diabetes and the selected NCD risk factors also targeted for control are tobacco use, harmful alcohol use, salt intake, obesity, raised blood pressure, raised blood glucose and diabetes, and physical inactivity [6].

Coupled to the rapid urbanization observed in Fako Division, the double crises (socio-political and COVID-19 pandemics) could increase the prevalence of NCDs through either inaccessibility to health facilities and/or stressors. The lock-downs imposed by these two crises have led to increase in sedentary life, psychological stress and inadequate exercise with a long term consequence of spikes in NCDs such as hypertension and diabetes [7]. These double crises have considerably disrupted the health system through reduction in access to health facilities and reduction in staff and essential medication for patients suffering from NCDs. There is consistent evidence across the globe that the COVID-19 pandemic has considerably disrupted NCDs services. This disruption has been particularly problematic for people living with chronic conditions and requiring long term care. Triage and telemedicine have been used to address this disruption in NCD services across the world.

The prevalence of HIV in Cameroon was 3.9% in 2015 [8]. The World Health Organization (WHO) estimates for deaths attributed to Non-Communicable Diseases (NCD) in Cameroon was 35.0% in 2018 [9]. The prevalence of HIV is 3.6% and that of hypertension is 31.1% in the South West Region (SWR) of Cameroon [2,8]. The prevalence of hypertension (38.0%) and dyslipidemia (51.0%) in HIV patients on ART have reached epidemic levels in Fako Division, SWR of Cameroon [2,3]. Fako Divisionas well as the other fast urbanizing divisions in Cameroonis experiencing a double burden of HIV and NCDs. Although evidence from high-income countries is definitive as to the emerging importance of NCDs in PLHIV, there are far fewer data and research advances regarding such conditions in low and middle income countries (LMICs). In Cameroon, the burden of NCDs and their risk factors among PLHIV remains largely unquantified.

Four behavioural risk factors are associated with increased risk of NCDs. There are tobacco use, physical inactivity, unhealthy diet and harmful use of alcohol. Primary prevention of NCDs is directed towards modifying these risk factors. These risk factors are widely prevalent among HIV patients in Cameroon. Behaviour change communication (BCC) is an important strategy for the modification of behavioural or lifestyle-associated risk factors of NCD. Mobile phone technology is viewed as a promising communication channel that offers the potential to improve healthcare delivery and promote behaviour change among vulnerable populations. A major advantage of mobile health (mHealth) interventions is the fact that they can be delivered to many individuals in a cost effective manner and in a relatively shorter time. There is a paucity or dearth of studies demonstrating the effect of mHealth in lifestyle modifications for NCDs, especially in LMIC and evidence for effectiveness of these interventions comes from reviews which have not included such countries [10]. Thus assessing the effect of mHealth intervention in bringing about changes in the behavioural and physiological risk factors of NCDs among HIV patients on ART in Fako Division is imperative.

2. Materials and Methods

2.1. Ethical and Administrative Consideration

For administrative approval, the study protocol was read and approved by South West Regional Delegation of Public Health and heads of the health facilities hosting the HTCs. Ethical clearance was obtained from the Faculty of Health Science Institutional Review Board, University of Buea, Cameroon. Participants were enrolled in the study after obtaining written and informed consent. The study was registered with the Clinical Trials Registry of South Africa. At the end of the intervention, the control group benefitted from messages on the prevention of NCDs.

2.2. Study Design

We conducted a non-randomized hospital based clinical trial over a period of one year (from June 2020 to June 2021).

2.3. Study Area and Setting

The study sites were Buea Regional Hospital and Limbe Regional Hospital (Figure 1). One of the HTCs served as the intervention group and the other the control group. These hospitals are specialized HIV treatment centres that provide free anti-retroviral therapy in addition to HIV counseling and testing services. According to the RTG of the Regional Delegation of Public Health for the South West Region report for 2020, a total of 18,000 HIV patients were receiving treatment in Fako Division [11]. Patients report every 1, 3 and 6 months for antiretroviral therapy refill depending on the availability of drugs. The number of HIV patients on ART has seen a hick because most patients have been transferred-in from the highly hit conflict areas to Fako Division which is relatively safer. The patients who attend the facility are of different socio-economic statuses. Information on NCDs is not collected in routine care at the facility during patient visits. Hypertension is sometimes screened for at every clinic visit, diabetes mellitus II, asthma, cardiomyopathy and osteoporosis are usually screened for when a patient

complains of certain symptoms during the routine follow up visits. Renal impairment is screened for among patients upon being started on tenofovir based regimen. However, some NCDs are screened for as a result of participation in research projects that require screening for certain ailments / medical conditions.

2.4. Sampling Method

We recruited the participants using a sequential or consecutive technique. We recruited subjects as they came for their refill. The assignment of the participants into the intervention and control group was done randomly.

2.5. Inclusion Criteria

We included adults aged 18 years and above, receiving ART in the HTCs, who had access to mobile phones with Short Message Service (SMS) facility and could read the messages in English language.

2.6. Exclusion Criteria

Individuals with impaired sight, hearing, inability to talk and those with severe mental retardation were excluded from the study. We also excluded those individuals who cannot be contacted after 3 successive call and those women who were pregnant at the time of the study.

2.7. Sample Size, Allocation and Blinding

The formula for sample size calculation for comparing between two groups when the end point is qualitative was used [12].

$$n = \frac{2\left(z_{\alpha/2} + z_{\beta}\right)^2 p(1-p)}{\left(p_1 - p_2\right)^2}$$

With the assumption of a 14.0% prevalence of smoking among HIV patients in Cambodia [13] at 95% confidence with 80% power, 130 participants per group will be needed for a 10% reduction in risk factors to be detected.

$Z_{\alpha/2} = 1.96$ at 5% precision.

$Z_{\beta} = 0.842$ at a power of 80%.

$P_1 - P_2$ = Difference in proportions of the events in the two groups.

P = pooled prevalence = [Prevalence in case group (P_1) + Prevalence in control group (P_2)]/2.

$P_1 = 14.0\%$, $P_2 = 4.0\%$

$P = [0.14 + 0.04]/2 = 0.09$

$P_1 - P_2 = 10\% = 0.10$ (difference in prevalence)

$$n = \frac{2(1.96 + 0.842)^2\, 0.09(1-0.09)}{(0.10)^2} = 128.6$$

We rounded up the sample size and aimed to recruit 130 participants in each group.

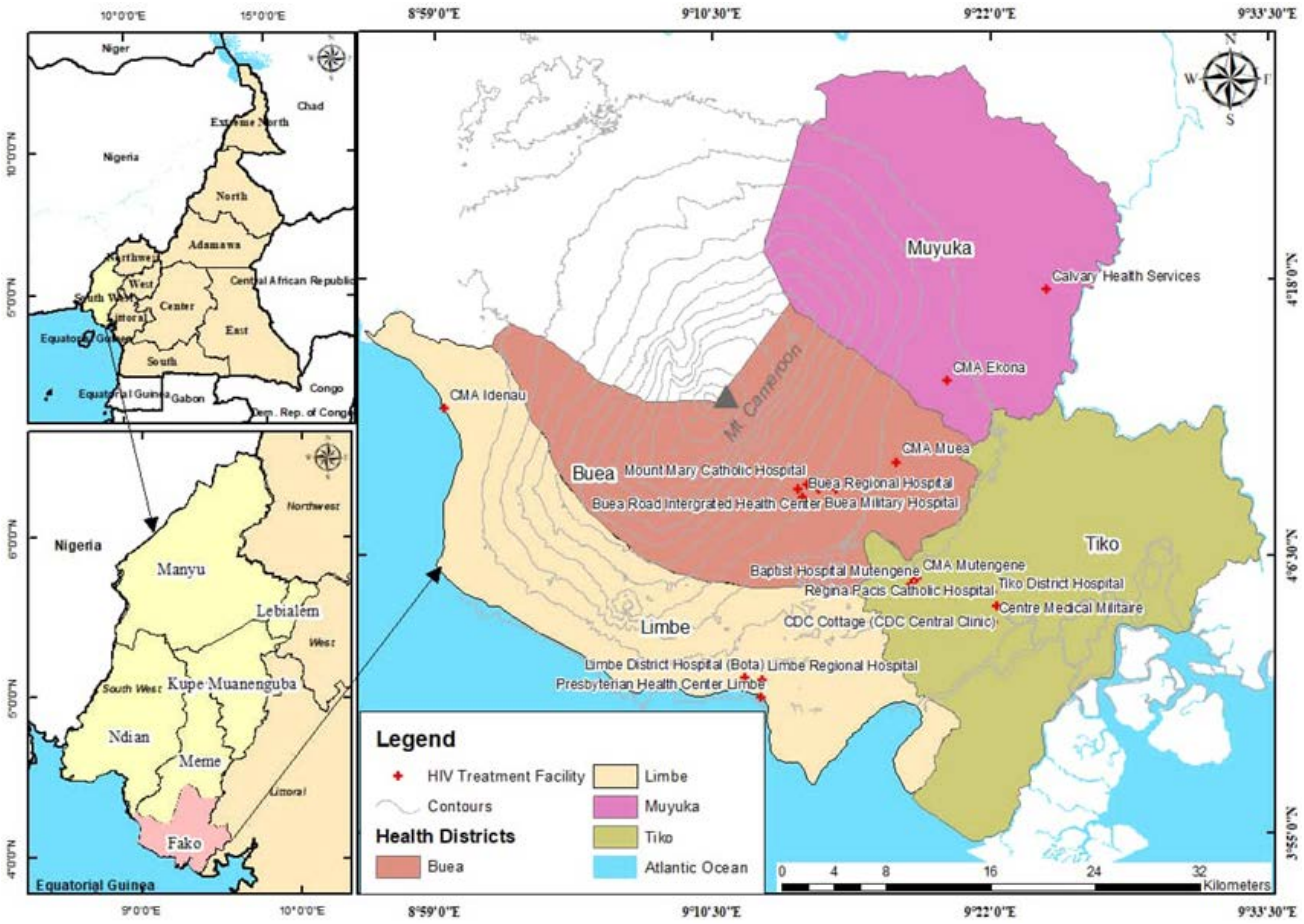

Figure 1. Map of Fako Division showing HIV Treatment Centers

The participants were allocated to intervention and control groups in the ratio of 1:1. The intervention and control groups were recruited from the two HTCs. A geographically stratified allocation procedure was applied. This was done to avoid information contamination or spill over due to interaction between the two groups.

Due to the nature of the intervention, it was not possible to blind the investigator and the participants to the allocation. However, the data collectors were blinded to the allocation.

2.8. Data Collection Procedure

We conducted the study in 3 phases—a two months long Pre-Intervention Phase followed by an 8 months long Intervention Phase, which was followed by a two months long Post-Intervention Phase. In the Pre-Intervention Phase, we collected baseline data from both groups using a pre-tested, semi-structured interview schedule based on the WHO STEPS approach for NCD risk factor surveillance, which will have been modified and validated in the Cameroon context. We collected personal and socio-demographic data and detailed information about behavioural risk factors of NCDs (improper diet, physical inactivity, mental stress, tobacco and alcohol use).

In the Intervention Phase, which lasted 8 months, we contacted the subjects in the intervention group on their mobile phone via telephone call once a month. Each telephone call lasted for about 20 minutes during which we reiterated the importance of modifying behavioural risk factors of NCD, addressed queries and provided positive reinforcement. The intervention package will also include weekly text messages via SMS. The text messages included short but catchy slogans and rhymes on the importance of modification of behavioural risk factors. Each message had an average of 25-30 words. The schedules of the messages were prepared addressing each behavioural NCD risk factor and messages were sent every week in rotation. At a time, only one risk factor was addressed. No such mHealth intervention package was given to the control group.

In the Post-Intervention Phase, we interviewed the participants and perform physical examination again using the same schedule as in the pre-intervention phase. The Post-Intervention Phase was carried out during similar climatic conditions as the baseline, to eliminate effect of seasonal differences in behaviour pattern.

Current smoking; Questions and pictorial show cards of tobacco products was used to identify current users (those who had smoked in the past 30 days).

Alcohol consumption; Questions were asked to determine the percentage of lifetime abstainers, past 12 months abstainers and current users of alcohol using the WHO protocol. Consumption of ≥60 gm of pure alcohol for men and ≥40 gm of pure alcohol for women on an average day in the past 30 days was considered harmful use [14] i.e. the consumption of more than 5 pegs of standard alcohol drink in a typical drinking session. To encourage respondents to disclose the alcohol and tobacco consumption habits, we maintained privacy during interviews and ensured respondents that responses would be reported anonymously.

Diet; Information was recorded on the number of days that respondents consumed fruit and vegetables in a typical week, and the number of servings of fruit and vegetables consumed on average per day. Less than five servings of fruits and vegetables per day was considered insufficient fruit and vegetable intake.

Physical activity; Physical activity was assessed using the Global Physical Activity Questionnaire (GPAQ) [14]. The GPAQ asks respondents about activity for transport purposes, vigorous and moderate activity at work, and vigorous and moderate activity in leisure time, and time spent sitting. Show-cards with culturally relevant examples was used to aid respondents in classifying activities. Analysis and categorization followed existing guidelines [14] and those who did not meet the criteria for vigorous and moderate intensity activities were categorized as having low physical activity.

History of raised blood pressure and blood glucose; Participants will be asked about their history of raised blood pressure or blood glucose and treatment advised by a doctor to control these (such as medicines prescribed, a special diet to be followed, advice to reduce salt intake, lose weight, stop smoking, or do more exercise).

Physical measurements; using the WHO STEPS protocol and recommended instruments, height and weight measurements, BMI calculations and blood pressure measurements were taken with much accuracy. Height and weight were measured and body mass index (BMI) was calculated according to the protocol. Height was recorded in centimeters using a portable standard stature scale. Weight was recorded in kilograms using a portable digital weighing scale (Seca, Germany). Waist and hip circumference were measured in centimeters using constant tension tapes (High Waist Circumference > 102cm for men and >88cm for women) (Seca, Germany) [15]. A BMI of ≥30.0 and between 25.0 and 29.9 was considered obese and overweight, respectively.

Blood pressure measurement; Blood pressure was measured using a digital, automated blood pressure monitor (OMRON digital device, OMRON, Netherlands) with an appropriate sized cuff. Two blood pressure readings were taken on all participants when they have rested in a seating position for at least 15 minutes. Furthermore, the participant should have an empty bladder when the measurements are taken, should not have coffee before or during the measurements, and should not talk during the measurements. The elbow should be supported during the measurements. A third reading was taken if there is a difference of more than 25 mmHg for systolic blood pressure (amount of force your arteries use when the heart pumps) or 15 mmHg for diastolic blood pressure (amount of force your arteries use when the heart relaxes) between the first two readings. The mean of all measures was used to declare the presence or absence of hypertension. Raised blood pressure was defined as having systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥ 90 mm Hg during the study, or being previously diagnosed as having hypertension. This was determined by documentation such as a treatment record book, or participant history of medication for high blood pressure [15].

Quality of Life: QoL was assessed using the WHO QoL Bref instrument – which has 26 questions relating to the physical, psychological, social and environmental domains of health [16].

2.9. Outcome and Other Measures

Our primary outcome was the percentage change in behavioural risk factors at the end of the study in the intervention group as compared to control group. These variables were expressed quantitatively and difference in means was assessed.

We expressed physical activity in terms of Metabolic Equivalent-minutes (MET-min) and weekly activity level of 600 or more MET-min was considered to be adequate, in accordance with WHO recommendations [14].

Diet was assessed in terms of number of servings of fruits or vegetables in a day. Standard definition of 'serving' was used as per WHO STEPS approach and a daily consumption of 5 or more servings of fruits or vegetables was considered to be adequate [14].

Alcohol use was assessed in terms of any form alcohol consumed in the last 12 months. Harmful alcohol use was considered consumed ≥20 g of pure alcohol for men and ≥10 g of pure alcohol for women on an average day in the past 30 days [14].

Tobacco use was assessed in terms of participants who had smoked any tobacco product in the past 30 days [14].

Our secondary outcomes included physiological risk factors of NCDs and QoL.

2.10. Statistical Analysis

Data analysis was done using Stata 13 and based on protocol (not intention to treat approach). Descriptive tables were made expressing categorical variables in terms of percentages and continuous variables in terms of mean and standard deviation. We checked for normality of quantitative data using Shapiro-Wilk test. Difference in baseline characteristics between control and intervention groups was tested using chi-square test for qualitative and analysis of variance for quantitative risk factor data. Paired sample t-tests were used to determine significance of difference between pre-intervention and post-intervention values in both control and intervention groups. A P value of less than 0.05 was taken to be statistically significant.

3. Results

3.1. Flowchart of Participants in the Study

Figure 2 depicts the flow of participants. We approached 400 adult HIV patients fulfilling the inclusion criteria and asked them to enroll for the study. Of these, 80 (20.0%) declined to participate. The remaining 320 subjects were allocated to control group (n=160) and intervention group (n=160) in a non-random way based upon the geographic location of the HTCs. Among the control group, 20 (12.5%) were lost to follow-up. Three women became pregnant during the study period hence becoming ineligible for the study. Among the intervention group, 25 (15.6%) were lost to follow up. Hence, of the 320 enrolled participants, 275 completed the study, thus the completion rate was 85.9%.

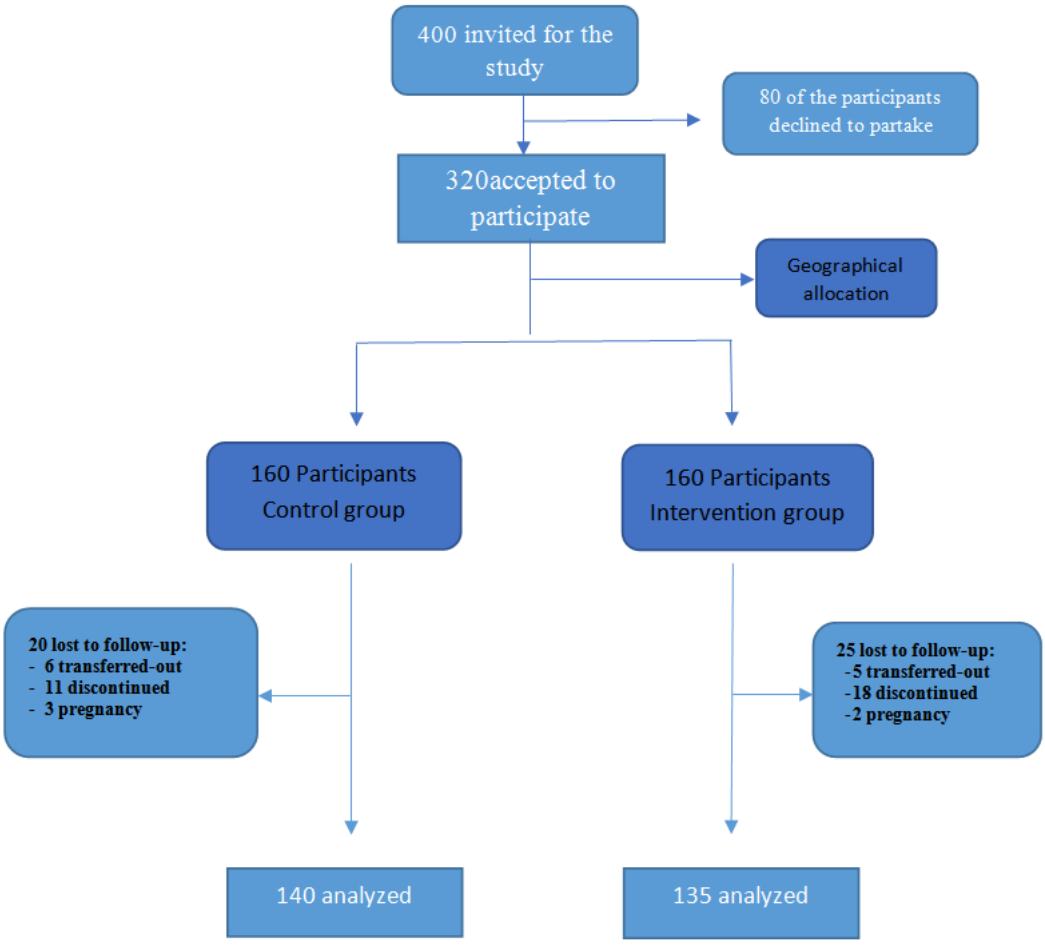

Figure 2. Flowchart chart for the recruitment and follow-up of participants

3.2. Socio-demographic Characteristics of Participants in the Intervention and Control Groups

Table 1 shows the socio-demographic characteristics of the participants in control and intervention groups. A Chi-square test was used to analyze differences in proportions of the characteristics of the two groups and no significant differences were found. Thus, the two groups were similar in terms of socio-demographic characteristics such as age, sex, education, occupation, marital status, ART regimen, duration on ART, WHO HIV stages and family history of hypertension at baseline.

3.3. NCDs Risk Factors and Quality of Life of Participants at Baseline in the Control and Intervention Groups

Table 2 shows the baseline data regarding behavioural and physiological risk factors of NCDs and the quality of life of participants in the control and intervention groups. No significant difference was found in any of the risk factors and quality of life and the two groups had similar risk factor profiles at baseline.

In categorical terms, inadequate diet was found to be universally prevalent in both groups at baseline. Less than one in five (20.0%) of the participants in both groups consumed less than 5 servings of fruits and vegetables per day. Insufficient physical activity of less than 600 MET-min per week was seen in 34 (25.2%) of the intervention group and 36 (25.7%) of the control group at baseline.

3.4. Percentage Change in Behavioural Risk Factors of NCDs after mHealth Intervention

Figure 3 depicts the primary outcome i.e., percentage change in behavioural risk factors of NCDs at the end of the study in the intervention group as compared to control group. Physical inactivity, inadequate diet and alcohol consumption significantly reduced from baseline to post intervention after the mHealth intervention in the intervention group but not in the control group. At the end of the intervention period, the percentage of participants consuming inadequate diet reduced significantly from 80.7% (n=109) at baseline to 73.3% (n=99) post-intervention in the intervention group. In the control group, this change was from 81.4% (n=114) at baseline to 78.6% (n=110) at the end of the study. Insufficient physical activity significantly reduced from 74.8% (n=101) at baseline to 65.2% (n=88) post-intervention in the intervention group at the end of the study while no change was observed in terms of percentage in the control group. At the end of the intervention period, the percentage of participants consuming alcohol reduced significantly from 41.5% (n=56) at baseline to 30.4% (n=41) post-intervention in the intervention group. In the control group, this change was from 41.4% (n=58) at baseline to 40.0% (n= 56) at the end of the study. Smoking did not show any significant reduction from baseline to post-intervention after the mHealth intervention in both the intervention and control groups.

Table 1. Socio-demographic characteristics of participants in the Control and intervention group

Characteristic	Intervention group (n=135), n (%)	Control group (n=140), n (%)	X^2	p-value
Age (years)			**0.007**	**0.996**
21 – 30	8 (5.9)	8 (5.8)		
31 – 50	84 (62.2)	87 (62.1)		
50+	43 (31.9)	45 (32.1)		
Gender			**0.040**	**0.840**
Male	39 (28.9)	42 (30.0)		
Female	96 (71.1)	98 (70.0)		
Marital status			**0.557**	**0.757**
Married	71 (52.6)	73 (52.2)		
Single	39 (28.9)	45 (32.1)		
Divorced/Widow	25 (18.5)	22 (15.7)		
Education			**0.573**	**0.902**
No formal	14 (10.4)	18 (12.9)		
Primary	53 (39.3)	55 (39.3)		
Secondary	50 (37.0)	51 (36.4)		
Tertiary	18 (13.3)	16 (11.4)		
Employment			**0.052**	**0.820**
Employed	104 (77.0)	111 (79.3)		
Unemployed	31 (23.0)	29 (20.7)		
WHO HIV stage			**0.564**	**0.811**
I-II	66 (48.9)	70 (50.0)		
III-IV	69 (51.1)	70 (50.0)		
ART Type			**0.199**	**0.660**
ART with PIs	07 (5.0)	9 (6.4)		
ART without PIs	128 (95.0)	131 (93.6)		
Duration on ART			**0.582**	**0.741**
1 – 5	54 (40.0)	50 (35.7)		
6 – 10	49 (36.3)	53 (37.9)		
11+	32 (23.7)	37 (26.4)		
Family History of HTN			**0.152**	**0.697**
No	86 (63.7)	86 (61.4)		
Yes	49 (36.3)	54 (38.6)		

Table 2. NCDs risk factors and quality of life of participants at baseline in the control and intervention groups

Characteristic	Intervention group (n=135)	Control group (n=140)	p-value
Behavioural risk factors of NCDs			
Smoking, n (%)	8 (5.9)	9 (6.4)	0.297
Alcohol consumption, n (%)	56 (41.5)	58 (41.4)	0.789
F/V serving/day, Mean (SD)	2.5 (0.6)	2.6 (0.7)	0.459
Physical activity (MET/Wk), Mean (SD)	243.3 (12.6)	241.6 (13.8)	0.363
Physiological risk factors of NCDs			
BMI (kg/m^2), Mean (SD)	26.4 (5.3)	27.1 (4.9)	0.703
Systolic BP (mmHg), Mean (SD)	125.4 (11.3)	124.9 (10.6)	0.523
Diastolic BP (mmHg), Mean (SD)	77.6 (9.6)	79.3 (10.8)	0.198
Quality of life score on 100			
Physical domain, Mean (SD)	68.3 (10.3)	69.8 (9.7)	0.895
Psychological domain, Mean (SD)	63.2 (9.9)	64.5 (9.6)	0.568
Social domain, Mean (SD)	60.9 (10.6)	60.1 (9.3)	0.748
Environmental domain, Mean (SD)	58.9 (10.9)	58.1 (8.9)	0.669

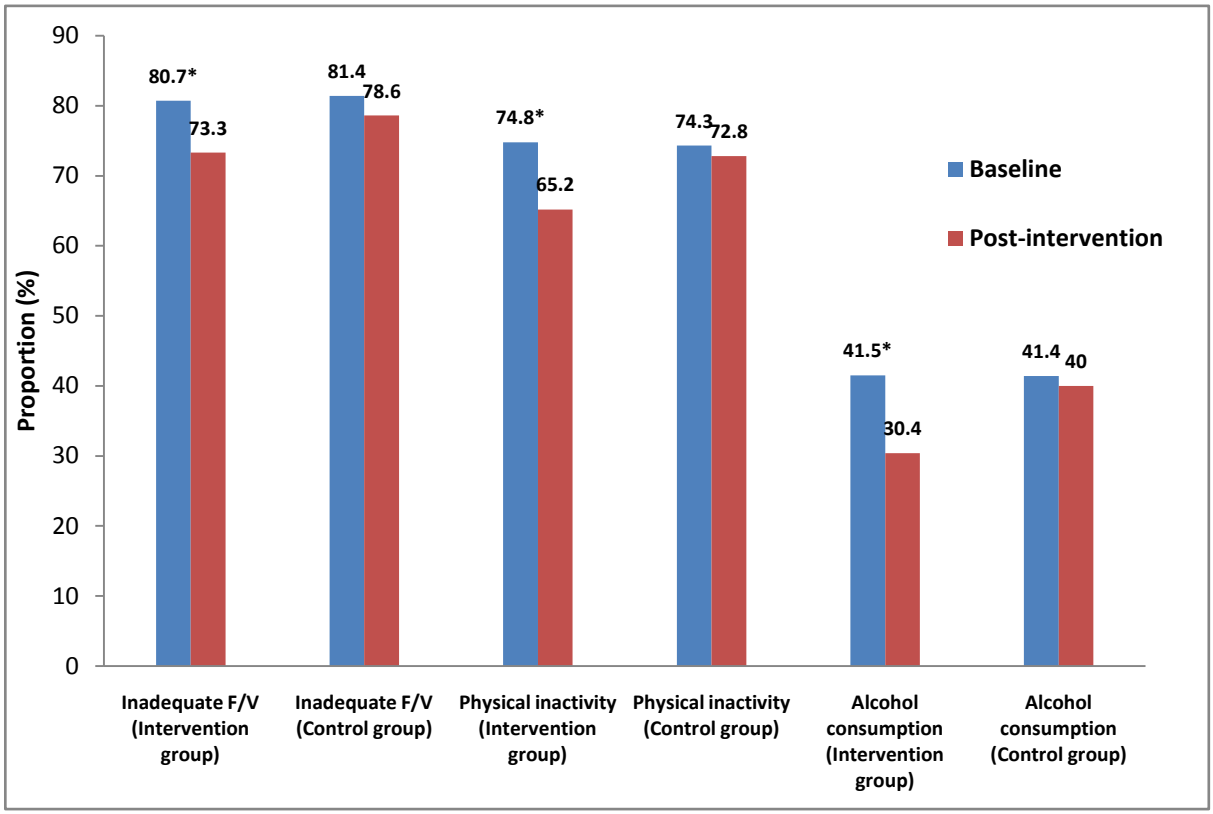

Figure 3. Percentage change in behavioural risk factors of NCDs after mHealth intervention (*significant at p <0.05)

3.5. Mean Change in NCDs Risk Factors and Quality of Life Score of Participants in the Control and Intervention Groups after the mHealth Intervention

Table 3 shows the mean change in NCDs risk factors (behavioural and physiological) and quality of life score after mHealth intervention in control and intervention groups. Paired t-test was used to determine the significance of the difference of the paired, normally distributed data. The mHealth intervention had a significant effect on fruit/vegetable servings, physical activity, BMI, SBP, physical and psychological domains of quality of life. The mHealth intervention did not have any effect on diastolic blood pressure and the environmental domain of quality of life. Mean number of servings of fruits and vegetables per day increased significantly in the intervention group but not in the control group following the mHealth intervention. In the intervention group, the mean number of daily servings of fruits and vegetables increased significantly from 2.5 at baseline to 4.2 post-intervention ($p<0.001$) while in control group, it decreased from 2.6 to 2.5 ($p=0.678$). Physical activity was found to increase significantly from an average of 243.3 at baseline to 301.1 MET-min wk day in the intervention group which was found to be statistically significant ($p<0.001$). This amounts to an increase of approximately 15 minutes of moderate activity per week (One minute of moderate-intensity activity is approximately equal to 4 MET). No statistically significant change in physical activity was found in the control group.

Table 3. Mean change in NCDs risk factors and quality of life score of participants in the control and intervention groups after the mHealth intervention

Characteristic	Intervention group (n=135)			Control group (n=140)		
	Baseline Mean (SD)	Post-intervention Mean (SD)	Mean difference (p-value[a])	Baseline Mean (SD)	Post-intervention Mean (SD)	Mean difference (p-value[a])
Behavioural risk factors of NCDs						
F/V serving/day, Mean (SD)	2.5(0.6)	4.2(0.7)	1.7(<0.001)	2.6(0.7)	2.5(0.5)	-0.1(0.678)
Physical activity(MET/wk), Mean	243.3(12.6)	301.1(10.3)	57.8(<0.001)	241.6(13.8)	248.6(11.7)	6.7(0.436)
Physiological risk factors of NCDs						
BMI (kg/m^2), Mean (SD)	26.4(3.3)	25.7(3.1)	-0.7(0.004)	27.1(3.9)	27.5(3.7)	0.4 (0.024)
Systolic BP (mmHg), Mean (SD)	125.4(11.3)	124.0(10.6)	-1.4(0.003)	124.9(10.6)	125.1(11.3)	0.2(0.234)
Diastolic BP (mmHg), Mean (SD)	77.6(9.6)	77.5(9.5)	0.1(0.564)	79.3(10.8)	79.4(10.7)	0.1(0.654)
Quality of life score on 100						
Physical domain, Mean (SD)	68.3(10.3)	70.9(10.2)	2.6(0.021)	69.8(9.7)	69.7(9.6)	-0.1(0.269)
Psychological domain, Mean (SD)	63.2(9.9)	65.3(9.7)	2.1(0.031)	64.5(9.6)	64.5 (9.7)	0 (1.000)
Social domain, Mean (SD)	60.9(10.6)	60.8(10.3)	-0.1(0.654)	60.1(9.3)	60.2(9.5)	0.1(0.554)
Environmental domain, Mean (SD)	58.9(10.9)	58.8(10.7)	-0.1(0.774)	58.1(8.9)	58.2(9.1)	0.1(0.397)

[a], Paired t-test used. NCDs, non-communicable diseases; MET, metabolic equivalent of task; BMI, body mass index, BP, Blood Pressure, SD, Standard deviation.

Significant reductions were also seen in the physiological risk factors in the intervention group as compared to control group after the mobile health intervention. Mean BMI in intervention group reduced from 26.4 at baseline to 25.7 at the end of the intervention period (p=0.004). In the control group, there was a significant increase in the mean BMI from 27.1 at baseline to 27.5 kg/m2 at the end of the intervention period (p =0.024). Mean systolic blood pressure reduced from 125.4 at baseline to 124.0 mmHg post-intervention in the intervention group which was found to be statistically significant (p=0.003). There was a marginal increase in mean systolic blood pressure in the control group from 124.9 at baseline to 125.1 mmHg which was not found to be significant (p=0.234). No significant difference was seen mean diastolic blood pressure in either group.

Among the 4 domains of quality of life, statistically significant changes were seen in the physical and psychological domains in the intervention group but not in the control group. The mean quality of life score for the physical domain increased significantly from 68.3 at baseline to 70.9 post-intervention in the intervention group (p=0.021) and the mean quality of life score for the psychological domain increased significantly from 63.2 at baseline to 65.3 post-intervention (p=0.031) in the same group. No statistically significant changes were seen in the mean quality of life score for the physical and psychological domains in the control group. The mean quality of life score for the social and environmental domains did not show any change from baseline to post-intervention in both the intervention and control groups.

4. Discussion

Our study showed that using mHealth interventions such as phone call and SMS for behavioural change communication (BCC) can be effective in reducing behavioural (inadequate diet, insufficient physical activity and alcohol consumption) and physiological (BMI and SBP) risk factors of NCDs among adult HIV patients on ART. The quality of life (physical and psychological domains) of these patients was equally improved by this mHealth intervention. Our findings are similar to those obtained in a study carried out in the general population in Delhi (India), where mHealth significantly reduced behavioural risk factors (unhealthy diet and insufficient physical activity) in the intervention group compared to control group. Body mass index (BMI), systolic blood pressure and fasting blood sugar level also showed significant difference in the intervention group as compared to controls [17]. Other studies, conducted in developed countries, have also demonstrated usefulness of SMS-based interventions in increasing physical activity and improving diet. A parallel-group randomized control trial (RCT) conducted in the United Kingdom found that SMS-based intervention significantly improved the physical activity level of the intervention group as compared to control group. The study concluded that text messages aid the recall of, and could enhance interventions that target, plans and goals related to increased physical activity [18]. A study from Sweden evaluated the effectiveness of a weight loss program delivered via SMS-based intervention. The program addressed regulation of diet as well physical activity and reported that by 12 months the experimental group had lost significantly more weight than the control group [19]. A systematic review published in 2016 reviewed 15 studies evaluating mHealth and eHealth interventions for promotion of healthy diets and physical activity in LMICs. The results of this systematic review suggested that eHealth and mHealth interventions could be effective in improving physical activity and diet quality in LMICs. Overall, the review showed that 50.0% of the eHealth and mHealth interventions were effective in increasing physical activity, and 70.0% of the identified interventions were effective in improving diet quality [20]. It is not possible to assess whether the phone calls or the text messages contributed more towards the change observed in this study. However, the feature of phone calling in the mHealth package provided a gateway for two-way communication. The text messages provided continuous input of health messages and the phone calls served to reiterate those messages, follow-up on progress and provide motivation and positive reinforcement to the subjects.

This study was carried out to evaluate the effectiveness of BCC delivered via mobile phones. Although inter-personal communication is the most effective tool for BCC, it is expensive to deliver in terms of time, money and man-power. An attractive feature of mHealth that makes it a promising alternative is its cost effectiveness. With the growing burden of NCDs in the community, such cost effective and innovative measures will be needed that can easily reach the masses.

5. Conclusion

Our mobile health intervention significantly reduced behavioural (inadequate F/V intake, physical inactivity and alcohol consumption) and physiological (BMI and SBP) risk factors among adult HIV patients on ART in Fako Division. The physical and psychological domains of quality of life significantly increased in patients in the intervention group but not in the control group.

6. Recommendation

The Ministry of Public Health alongside other stakeholders should optimize the use of mobile health in HTCs to effectively reduce behavioural and physiological risk factors of NCDs and improve the quality of life among HIV patients on ART.

7. Strengths and Limitations

The strength of our study is that we evaluated behavioural, physiological risk factors of NCDs as well as quality of life of adult HIV patients on ART. Since behavioural risk factors and quality of life are self-reported and based on recall, they are prone to bias. Anthropometric measurement and blood pressure measurement in our study provided objectivity and reduced bias. Further, there was a geographic separation between control and intervention group to prevent information spill-over or contamination. Participants living further apart are less likely to interact and pass on the health promotion messages to each other. Finally, our study was conducted in randomly selected HTCs. This enhances the external validity of our study. Our study had some limitations; Firstly, allocation to control and intervention group was non-randomized and this may introduce selection bias. Secondly, blinding of the participants and investigator was also not possible in this study design and this may be a source of bias. Thirdly, behavioural risk factors and quality of life were self-reported and hence prone to recall and self-desirability or social desirability bias.

8. Perspectives

Our study has demonstrated the usefulness of mHealth for health promotion and lifestyle modification among HIV patients on ART. However, there is a need for more such studies, preferably large-scale RCTs to be conducted to generate good quality evidence.

Abbreviations

AIDS: Acquired Immuno-deficiency Syndrome; ART: Anti-retroviral therapy; BMI; Body Mass Index; COVID-19: Coronavirus Disease 2019; CVDs: cardiovascular diseases; DBP; Diastolic Blood Pressure; HTCs: HIV Treatment Centers; GPAQ: Global Physical Activity Questionnaire; MET: metabolic Equivalent Time; HIV: Human immunodeficiency virus; LMIC: Low- and middleincome countries; mHealth; Mobile Health; NCD: Non-communicable disease; PLWH: People living with HIV; SWR: South West Region; SBP; Systolic Blood Pressure; SSA: Sub-Saharan Africa; UTT; Universal Test and Treat; WHO: World Health Organization.

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Availability of Data and Materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Competing Interests

The authors declare that they have no competing interests.

Consent for Publication

This manuscript does not contain any individual's data. Consent for publication was obtained from the PhD thesis supervisors.

Ethics Approval and Consent to Participate

This study was approved for exemption by the Faculty of Health Sciences of the Institutional Review Board at University of Buea.The study was registered with the Clinical Trials Registry of South Africa. At the end of the intervention, the control group benefitted from messages on the prevention of NCDs.

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