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Dyslipidemia and Associated Factors Among a High-Risk Population for Stroke: A Cross-Sectional Study

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ABSTRACT

Aims: Dyslipidemia is a major modifiable risk factor for stroke; however, it is poorly understood among patients at risk of stroke in Uganda. This study is aimed at determining the prevalence of dyslipidemia and identifying associated factors among a Ugandan sample at risk for stroke.

Methods: This was a hospital based cross-sectional study conducted across three Ugandan sites. The serum lipid levels were determined following the National Cholesterol Education Program guidelines. Data were analyzed with STATA employing univariable and multivariable logistic regression. Statistical significance was set at $p < 0.05$.

Results: We enrolled 247 study participants with a mean age (SD) of 55.4 (12.0) years. Majority of the participants were female, $n = 168$ (68%). About 81% ($N = 199$) had elevated serum lipid levels. Sixty-one (24.7%) had elevated levels of total serum cholesterol, whereas half of female participants had abnormally low levels of HDL cholesterol. About a third ($N = 82$ and 84 , respectively) had elevated serum LDL and triglycerides. Nearly 40% ($N = 98$) were obese and 23.5% had a sedentary lifestyle ($N = 58$). Only 20.2% ($N = 50$) were receiving lipid lowering drugs. Prior family stroke history and personal history of stroke had lower odds of 58% (AOR = 0.42, 95% CI: 0.20–0.88, $p = 0.022$); and 64% (AOR = 0.36, 95% CI: 0.17–0.76, $p = 0.008$), respectively, of having dyslipidemia.

Conclusions: Approximately four in five Ugandans at risk of stroke have dyslipidemia. The majority also have low HDL-c levels. Implementation of systematic screening and provision of statin therapy among those at high risk for stroke is urgently needed to reduce stroke burden in Uganda.

Trial Registration: ClinicalTrials.gov identifier: NCT04685408

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1 | Introduction

Traditional stroke risk factors like dyslipidemia are an emerging public health problem especially within LMICs like Uganda. There are limited strategies such as appropriate use of lipid lowering agents to reduce the stroke risk in these individuals [1]. Coupled with other stroke risk factors like sedentary lifestyle, tobacco and alcohol use, elevated serum lipid levels substantially increase the stroke risk [2]. The role of an increasing aging population and rural–urban migration, change of traditional diet to fast foods might have an important role in increasing the burden of stroke in Uganda.

In Uganda, stroke burden is growing and affecting relatively young individuals where it is a severely neglected condition [3, 4]. Dyslipidemia is an important stroke risk factor along with hypertension and diabetes. Dyslipidemia leads to atherosclerosis, with a buildup of fatty plaque deposits that narrow the lumen of blood vessels or may dislodge and impede blood flow to the brain [5]. This makes dyslipidemia an important target for stroke primary and secondary prevention.

Several studies have described a relationship between dyslipidemia and stroke such as total cholesterol having an inverse correlation with intracerebral hemorrhage, whereas raised levels of HDL-cholesterol were protective against ischemic stroke, whereas triglycerides are responsible for atherosclerosis and atherothrombosis [6–9]. Understanding the lipid profile patterns among a high-risk population for stroke would help in designing strategies to address modifiable stroke risk factors to improve their outcomes. High low-density lipoprotein (LDL), low high-density lipoprotein (HDL), and elevated triglycerides (TG) levels are particularly linked to stroke risk, as they accelerate atherosclerosis, impair vascular health, and have been reported as independent risk factors for cardiovascular accidents [10].

In spite of the fact that statins are known to be effective in reducing stroke risk, prior studies have reported low statin use among high-risk populations for primary and secondary prevention in sub-Saharan Africa [11]. There are few data on the prevalence of dyslipidemia and related variables in Ugandans at high risk for stroke, despite the rising burden and mortality attributed to stroke in this population [12, 13]. The current study's objective was to evaluate the prevalence of dyslipidemia and associated risk factors in a Ugandan sample at risk for stroke.

2 | Materials and Methods

2.1 | Methods

This cross-sectional study was conducted from January 2021 to June 2021 at three Ugandan hospitals, namely Mulago hospital, Nsambya hospital, and Mbarara hospital, on patients at high risk for stroke. The study participants were consecutively screened and enrolled from the neurology outpatient clinics of each of the hospitals. The study was conducted during the second wave of the COVID pandemic. Following the Ugandan Ministry of Health guidelines to ensure study participant and staff safety, the local and institutional COVID-19 guidelines were followed. These included wearing a mask, physical distancing,

maintaining hand hygiene, and regularly disinfecting the study equipment and surfaces.

The inclusion criteria for the study included adults aged 18 years and above, with two or more known stroke risk factors such as hypertension based on the European Society of Cardiology (ESC) and European Society of Hypertension (ESH) Guideline (ESC-ESH) and the World Health Organization cardiovascular disease risk charts [14, 15], diabetes mellitus [16], obesity [17], smoking, problem alcohol use and sedentary lifestyle, and so on. Exclusion criteria included participants with a diagnosis of dementia, sickle-cell disease, pregnancy or those unable to undertake and participate in study procedures were excluded from participation.

A detailed history and clinical examination were performed with details of prior stroke or transient ischemic attack within the past 5 years collected. Written informed consent was provided before participating in the study procedures by the study participants.

The sample size for this cross-sectional study was based on the primary study that focused on systolic blood pressure (BP) reduction among patients at high risk for stroke [18]. In the preliminary mixed model data, we observed a difference in systolic BP from baseline to 24 weeks of 13.22 (SD \pm 25.84) mmHg and within a subject correlation parameter value of 0.57. We conservatively estimate our sample size, based upon a difference of 10 mmHg, the magnitude of change in BP across a large sample with varying baseline BP levels and comorbidities [19]. Our projected sample size is $n = 246$, with 123 participants per arm, assuming a 25% attrition and a type I error level of 0.05 and a power of 0.80.

A complete clinical examination was performed to determine the body mass index and BP measurement. A 5-mL overnight fasting blood sample was collected from the study participants to determine the serum fasting lipid levels. Samples were centrifuged at 3500 rpm for 5 min for the extraction of serum. The lipid profile was determined using an enzymatic colorimetric test method for total cholesterol, HDL, LDL, and TG using a COBAS 6000 analyzer (Roche diagnostics). Dyslipidemia was defined as having either singly or a combination of an elevated cholesterol > 5.17 mmol/L, elevated LDL > 4.11 mmol/L, elevated TG > 2.3 mmol/L, or HDL < 1.15 mmol/L for men and < 1.3 mmol/L for women [20].

Problem alcohol use was assessed with the Alcohol Use Disorders Identification Test (AUDIT) [21]. The AUDIT total score ranges from 0 to 40, with higher scores indicating more severe problems with alcohol. Sedentary lifestyle was determined using the Global Physical Activity Questionnaire (GPAQ) [22].

2.2 | Statistical Analysis

Stata Version 18 software was used for data analysis. The normally distributed continuous variables are reported as means \pm SD, whereas frequency and percentages were used for categorical variables. We analyzed the number and percentage of participants with elevated values of each lipid showing their distribution by sociodemographic characteristics. Logistic

regression was used to identify factors associated with dyslipidemia. All factors from a univariate logistic regression with $p < 0.05$ were included and retained in a multivariable logistic regression. Factors included in a multivariable logistic regression were gender, marital status, family history of stroke, and personal history of stroke. The Wald test statistic was used to determine the significance of the associated factors.

3 | Results

Among the 247 study participants at risk for stroke, the mean age (\pm SD) was 55.4 (\pm 12.0), with a range of 20–90 years. About 68% (168/247) of the study participants were female, with 20% having a positive family history of stroke. Ninety-eight of the study participants were obese based on the BMI scores, with only 20.2% (50/247) of the study participants receiving lipid lowering drugs.

Sixty-one study participants had elevated total serum cholesterol, whereas half of female study participants had abnormally low levels of HDL cholesterol (see Table 1). About a third of participants had elevated serum LDL and TG. Overall, females had a higher level of abnormal serum lipids compared with males. Those with primary level education had abnormally higher levels compared with other educational levels (see Table 2).

For this analysis, elevated cholesterol was defined as > 5.17 mmol/L or elevated LDL > 4.11 mmol/L and elevated TG > 2.3 mmol/L. For HDL, abnormal values of concern are lower than the reference range and differ for men and women. Abnormal HDL was defined as HDL < 1.15 mmol/L for men and < 1.3 mmol/L for women.

3.1. Factors Associated With Dyslipidemia Among the Study Participants

The prevalence of dyslipidemia was 80.6% (199/247) based on the definition of having one or a combination of elevated serum lipid results. Bivariate analysis identified several factors significantly associated with dyslipidemia, including female gender, marital status, family stroke history, personal history of stroke, age, education level, alcohol use, hypertension at baseline, problem alcohol use, diabetes mellitus, sedentary lifestyle, and obesity showed no significant association.

Results in Table 3 indicate that in the multivariate model, those who had a family stroke history and personal history of stroke had reduced odds of 58% (AOR = 0.42, 95% CI: 0.20–0.88, $p = 0.022$); and 64% (AOR = 0.36, 95% CI: 0.17–0.76, $p = 0.008$), respectively, of having dyslipidemia.

4 | Discussion

This study set out to determine the serum lipid levels among a population at risk for stroke in Uganda. Overall, a high proportion of study participants (80.6%) had at least one type of lipid abnormality, with 54.2% of the female participants having an

TABLE 1 | Baseline demographic and clinical characteristics of the TEAM Uganda sample ($N = 247$ randomized sample).

Variable	N (%)	Mean (SD), range
Age (years)		55.4 (12.0), 20–90
Gender		
Male	79 (32.0)	
Female	168 (68.0)	
Educational level		
None	18 (7.3)	
Primary	118 (47.8)	
Secondary	87 (35.2)	
Tertiary	24 (9.7)	
Marital status		
Single	15 (6.1)	
Married	132 (53.4)	
Separated/divorced/ widowed	100 (40.5)	
Currently employed/ working ^a	162 (65.6)	
Residency status		
Rural	53 (21.5)	
Suburban	111 (44.9)	
Urban	83 (33.6)	
Family stroke history	50 (20.2)	
Stroke risk factors at screening		
Systolic BP ≥ 140	247 (100)	
History of diabetes mellitus (yes)	72 (29.1)	
History of hyperlipidemia (yes)	199 (80.6)	
Obesity	98 (39.7)	
Current smoker	3 (1.2)	
Sedentary lifestyle	58 (23.5)	
Problem alcohol use	26 (10.5)	
History of lifetime stroke	49 (19.8)	
Total number of stroke risk factors (including HTN) at screening		3.0 (0.9), 2–6
Systolic BP at screen		158.1 (14.9) 140–216
Diastolic BP at screen		95.4 (11.4) 71.5–132
Systolic BP at baseline		143.0 (19.8), 94.5–206

(Continues)

TABLE 1 | (CONTINUED)

Variable	N (%)	Mean (SD), range
Diastolic BP at baseline		89.3 (14.0), 61–136
ESC-ESH 2018 guideline HTN ^b at baseline		
< Grade 1 (SBP < 140 and DBP < 90)	93 (37.7)	
Grade 1	83 (33.6)	
Grade 2	47 (19.0)	
Grade 3	24 (9.7)	
Serum cholesterol		4.5 (1.1), 1.7–7.1
Proportion with elevated value	61 (24.7)	
Serum HDL (proportion with abnormal (low) value)		1.6 (2.8), 0.3–4.4
Men (<i>n</i> = 79)	25 (31.6)	
Women (<i>n</i> = 166)	90 (54.2)	
Serum LDL		3.0 (1.3), 0.4–8.3
Proportion with elevated value	82 (33.2)	
Serum triglycerides		1.6 (1.0) 0.3–7.7
Proportion with elevated value	84 (34.0)	
HbA1c		6.1 (1.9), 2.0–15.0
BMI		28.7 (5.8), 16.8–45.5
Proportion with obesity	98 (39.7)	
AUDIT total score		1.0 (3.5), 0–30
Proportion with harmful drinking behavior ^c	8 (4.9%)	
Current Smoker (<i>N</i> /%) ^d	4 (1.6)	
Receiving medication treatment for HTN		
No	9 (3.6)	
Yes (at least one drug)	238 (96.4)	

Note: For this analysis, elevated cholesterol was defined as > 5.2 mmol/L. elevated LDL was defined as > 3.4 mmol/L and elevated triglycerides was defined as > 1.7 mmol/L. Abnormal HDL was defined as < 1.0 mmol/L for men and as < 1.3 mmol/L for females. Obesity defined as BMI > 30.

Abbreviations: AUDIT, alcohol use disorders identification test; BMI, body mass index; BP, blood pressure; HTN, hypertension; SD: standard deviation.

^aIncludes self-employed work at home or farming.

^bESC-ESH Grade 1—SBP 140–159 mmHg and/or DBP 90–99 mmHg, grade 2—SBP 160–179 mmHg and/or DBP 100–109 mmHg, grade 3—SBP ≥ 180 mmHg and/or DBP ≥ 110 mmHg.

^cHarmful drinking behaviors based on AUDIT score defined as total score > 8.

^dCurrent smoke based on baseline assessment using the global adult tobacco survey (GATS).

abnormally low level of HDL, whereas a third of study participants had elevated triglyceride, LDL, and 24.7% had elevated serum cholesterol. Family stroke history and those who were either married or separated/divorced were associated with dyslipidemia. Only 20.2% (50/247) of the study participants were receiving lipid lowering drugs.

Dyslipidemia is an important risk factor and contributes to the burden of stroke. These findings illustrate a potential area of focus for health care workers which can be modified through various interventions to reduce the burden of stroke in our settings. Few studies have explored serum lipid levels among high-risk populations for stroke in sub-Saharan Africa. Studies that have been conducted in Ethiopia and Egypt and which focused on coronary artery disease (CAD) indicate similar levels of dyslipidemia at 80.3% and 80%, respectively [23, 24]. A study among stroke patients in Palestine reported 61.3% of patients having low HDL, 28.57% had high LDL, which is like this study [25]. These therefore emphasize the significance of lipid abnormalities among those at risk of stroke and the need to assess to minimize the risk of stroke.

Personal history (AOR 0.36) and family history of stroke (AOR 0.42) had lower odds of having dyslipidemia. Patients with a family history of cardiovascular disease are more likely to recognize that their risk for CVD might be higher than those without, hence they may have better awareness and higher treatment rates for dyslipidemia. This can be explained by the health belief model as those who believe they are more vulnerable to developing a certain disease are likely to be more alert to their health status and make more efforts to reduce the threat of that disease [26]. Few studies have examined the relationship between an FH of CVD and awareness, treatment, and control rates of dyslipidemia, especially in the African context. Family history of stroke may be a good predictor of dyslipidemia in our settings, as dyslipidemia in our settings might have a genetic predisposition and have a role in the associated cardiovascular disease prevalence, including hypertension.

Majority of the study participants had low HDL-c levels; this is like several studies from Africa indicating similar findings [27–29]. Low levels of HDL-c are thought to contribute to structural and functional changes leading to arterial rigidity [30] and have been associated with an increase in cardiovascular risks and sequelae. HDL-c exerts its cardio-protective effects mainly via its role in the reverse cholesterol transport pathway by promoting the removal of cholesterol from peripheral cells and preventing atherosclerosis [31]. Low levels of HDL-c have also been reported to be a strong predictor of the occurrence and recurrence of myocardial infarction and stroke [32, 33]. There were no significant differences between male and female study participants as compared with earlier studies which have reported differences in HDL levels based on gender. The variations in the study findings may be attributed to genetic factors between populations and age differences between the studies.

In this study, the prevalence of raised TG was 34%. This finding was almost comparable with the findings from Ethiopia among coronary heart disease patients with 31%. These results

TABLE 2 | Distribution of dyslipidemia by sociodemographic characteristics of the TEAM Uganda sample (N = 247 randomized sample).

Variables	Total n (%) (N = 247)	Males			Females		
		TC > 5.2 mmol / L (N = 61)	TG > 1.7 mmol / L (N = 84)	LDL - c > 3.4 mmol / L (N = 82)	HDL - c < 1.0 mmol / L (N = 25)	HDL - c < 1.3 mmol / L (N = 90)	
Number and percentage with elevated values		61/247 (24.7%)	84/247 (34.0%)	82/247 (33.2%)	25/79 (31.6%)	92/168 (54.8%)	
Age in years—mean (SD), range	55.4 (12.0), 20–90	56.5 (13.4), 20–86	55.1 (11.9), 26–84	56.7 (12.7), 20–90	60.2 (13.4), 26–90	54.2 (12.1), 20–79	
Gender							
Male	79 (32.0)	12 (19.7)	26 (31.0)	21 (25.6)	—	—	
Female	168 (68.0)	49 (80.3)	58 (69.0)	61 (74.4)	—	—	
Educational level							
None	18 (7.3)	5 (8.2)	9 (10.7)	5 (6.1)	3 (12.0)	10 (10.9)	
Primary	118 (47.8)	26 (42.6)	41 (48.8)	33 (40.2)	13 (52.0)	50 (54.3)	
Secondary	87 (35.2)	25 (41.0)	26 (31.0)	34 (41.5)	5 (20.0)	27 (29.3)	
Tertiary	24 (9.7)	5 (8.2)	8 (9.5)	10 (12.2)	4 (16.0)	5 (5.4)	
Marital status							
Single	15 (6.1)	4 (6.6)	5 (6.0)	3 (3.7)	1 (4.0)	5 (5.4)	
Married	132 (53.4)	22 (36.1)	45 (53.6)	32 (39.0)	20 (80.0)	36 (39.1)	
Separated/ Divorced/Widowed	100 (40.5)	35 (57.3)	34 (40.4)	47 (57.3)	4 (16.0)	51 (55.5)	
Currently employed/ working ^a	162 (65.6)	33 (54.1)	55 (65.5)	51 (62.2)	23 (92.0)	56 (60.9)	
Residency status							
Rural	53 (21.5)	11 (18.0)	17 (20.2)	9 (11.0)	10 (40.0)	15 (16.3)	
Suburban	83 (33.6)	21 (34.4)	28 (33.3)	28 (34.1)	9 (36.0)	35 (38.0)	
Urban	111 (44.9)	29 (47.5)	39 (46.4)	45 (54.9)	6 (24.0)	42 (45.7)	

^aIncludes self-employed work at home or farming.

TABLE 3 | Factors associated with dyslipidemia among the TEAM Uganda sample ($N = 247$ randomized sample).

	Number of participants	Number and percentage with dyslipidemia (%)	95% CI for prevalence of dyslipidemia	Unadjusted odds ratio (OR) (95% CI)	p^a	Adjusted OR ^b (95% CI)	p^a
Age in years				1.02 (0.99, 1.05)	0.143		
Gender							
Male	79	57 (72.2%)	61.1%–81.0%	1.00		1.00	
Female	168	142 (84.5%)	78.2%–89.3%	2.11 (1.11, 4.02)	0.024	1.76 (0.84, 3.67)	0.134
Educational level							
Primary/ none	136	112 (82.4%)	75.9%–87.9%	1.00			
Secondary/ Tertiary	111	87 (78.4%)	69.7%–85.1%	0.78 (0.41, 1.46)	0.433		
Marital status							
Single	15	10 (66.7%)	38.2%–86.6%	1.00		1.00	
Married	132	100 (75.8%)	67.6%–82.4%	1.56 (0.50, 4.91)	0.445	1.52 (0.43, 5.36)	0.517
Separated/ divorced	100	89 (89.0%)	81.1%–93.8%	4.04 (1.17, 14.02)	0.028	3.65 (0.99, 13.39)	0.051
Currently employed/ working							
Unemployed	85	66 (77.6%)	67.4%–85.4%	1.00			
Employed/ working	162	133 (82.1%)	75.4%–87.3%	1.32 (0.69, 2.53)	0.402		
Residency status							
Rural	53	44 (83.0%)	70.1%–91.1%	1.00			
Suburban	111	86 (77.5%)	68.7%–84.4%	0.70 (0.30, 1.64)	0.414		
Urban	83	69 (83.1%)	73.3%–89.8%	1.01 (0.40, 2.53)	0.986		
Family stroke history							
No	197	165 (83.8%)	77.9%–88.3%	1.00		1.00	
Yes	50	34 (68.0%)	53.6%–79.6%	0.41 (0.20, 0.83)	0.014	0.42 (0.20, 0.88)	0.022
Systolic BP \geq 140							
Normal	100	85 (85.0%)	76.5%–90.8%	1.00			
BP \geq 140	147	114 (77.6%)	70.0%–83.6%	0.61 (0.31, 1.19)	0.149		
Diabetes							
No	159	127 (79.9%)	72.9%–85.4%	1.00			
Yes	88	72 (81.8%)	72.2%–88.6%	1.13 (0.58, 2.21)	0.712		
Obesity							

(Continues)

TABLE 3 | (CONTINUED)

	Number of participants	Number and percentage with dyslipidemia (%)	95% CI for prevalence of dyslipidemia	Unadjusted odds ratio (OR) (95% CI)	<i>p</i> ^a	Adjusted OR ^b (95% CI)	<i>p</i> ^a
No	149	116 (77.9%)	70.4%–83.8%	1.00			
Yes	98	83 (84.7%)	76.0%–90.6%	1.57 (0.80, 3.08)	0.186		
Sedentary lifestyle							
No	189	155 (82.0%)	75.8%–86.9%	1.00			
Yes	58	44 (75.9%)	63.0%–85.3%	0.69 (0.34, 1.40)	0.302		
Problem alcohol use							
No	221	180 (81.4%)	75.7%–86.1%	1.00			
Yes	26	19 (73.1%)	52.2%–87.1%	0.62 (0.24, 1.57)	0.311		
Personal history of stroke							
No	198	167 (84.3%)	78.6%–88.8%	1.00		1.00	
Yes	49	32 (65.3%)	50.7%–77.5%	0.35 (0.17, 0.71)	0.003	0.36 (0.17, 0.76)	0.008
ESC-ESH 2018 Guideline HTN ^a at baseline							
Grade 0	93	77 (82.8%)	73.6%–89.3%	1.00			
Grade 1	83	68 (81.9%)	72.0%–88.9%	0.94 (0.43, 2.05)	0.880		
Grade 2	47	36 (76.6%)	62.1%–86.8%	0.68 (0.29, 1.61)	0.382		
Grade 3	24	18 (75.0%)	53.1%–88.8%	0.62 (0.21, 1.82)	0.386		
Harmful drinking							
No	238	193 (81.1%)	75.6%–85.6%	1.00			
Yes	9	6 (66.7%)	28.1%–91.1%	0.47 (0.11, 1.94)	0.294		

^aUsing Wald test.

^bAll factors with unadjusted *p* < 0.05 including gender, marital status, family stroke history, and personal history of stroke were included and adjusted for in a multivariable logistic regression. The adjusted analysis included all the 247 observations (no missing data).

are higher than 18.9% reported from a study in Cameroon [34]. Triglyceride concentration has strong associations with atherosclerotic cardiovascular disease (ASCVD) risk [35]. It is important to note that the data on dietary intake and physical activity were self-reported and may not have been entirely accurate.

Despite the recommendations from several guidelines and experts, there is still suboptimal use of lipid lowering agents, especially statins, to reduce cardiovascular diseases. Only 20.2% of our study participants received lipid lowering agents despite having high levels of dyslipidemia. This is lower than findings from other studies in similar settings, who reported 40%–45.5% [36, 37]. The discrepancy between the findings could be the result of the difference in study participants, whereby some patients receive care from a specialist, whereas others might be receiving care from medical officers whose prescription

behaviors may vary. Harmonizing and ensuring guidelines for primary and secondary prevention of stroke is needed in our settings.

Instituting lifestyle modifications that are appropriate for this stroke high-risk group are needed targeting the CVD risk through mechanisms such as smoking cessation, weight reduction, and increased physical activity and dietary intake. Substantial evidence indicates that diet and exercise interventions improve hypertension and dyslipidemia [20]. The development of screening programs for patients attending health care and providing health education is needed to stem the growing burden of CVD in our populations.

The study relied on self-reported information provided by study participants or caregivers; it raises the potential for recall bias.

Due to the cross-sectional study design, we were unable to infer causality due to the difficulty in determining the correct temporal order of exposure and outcome. Whereas the study drew representation from three geographical locations: rural, suburban, and urban settings, it may still not represent the full population at risk of stroke in Uganda. Therefore, generalizability may be limited to the country since the study population was recruited from hospital clinics, representing a more severe, help-seeking group. We also note that a limitation of residual confounding might have occurred as key variables like dietary intake, antihypertensive medication effects, socioeconomic factors, and genetics are not controlled. Well-designed studies that are powered to address this might be needed to explore this further. Some of the dyslipidemias might be attributed to genetics, which was also out of scope for this study. The elevated lipid levels may also be part of a myriad of comorbidities that might be sub-optimally managed or controlled. Our sample may not thus be generalizable to the full range of Ugandans with HTN.

In conclusion, approximately 4 in 5 Ugandans at risk of stroke have dyslipidemia. The majority also have low HDL-c levels. Targeted interventions are urgently needed to address these potentially modifiable risk factors and reduce stroke burden in Uganda.

Author Contributions

M.S., E.T.K., and Mark K. conceived the study idea. S.N.M., Martin K., J.N., D.B., C.C., L.M., J.N.N., S.M., C.J.B., J.Y., M.S., E.T.K., and M.K. contributed to the research design and participated in data collection, management, analysis and interpretation, writing of the report, and the decision to submit the report for publication. M.S., C.J.B., J.Y., and M.N.K. wrote the first draft of the manuscript.

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Disclosure

All authors read and approved the final manuscript. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Ethics Statement

The study was approved by the following two IRB committees from Case Western Reserve University (CWRU) IRB-STUDY20200882 and Makerere University, School of Medicine, Research and Ethics Committee (SOMREC) Mak-SOMREC-2020-179. Regulatory approval was from the Uganda National Council of Science and Technology; UNCST HS2944ES. Written informed consent was obtained from the study participants before enrolment into the study.

Consent

The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The authors declare that data supporting the findings of this study are available within the article.

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