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Siriraj Stroke Score Validity in Distinguishing Ischemic from Haemorrhagic Stroke among Patients with Stroke at Saint Francis Hospital in Kampala, Uganda

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Abstract: ***Background: Stroke remains an increasing health problem in Uganda, as the number of hypertensive and diabetic patients rises. It is one of the most devastating diseases, causing gross physical impairment and death. The early and rapid detection of stroke type is very important in mitigating the stroke burden and therefore improving its management. The brain CT-Scan is the Gold Standard tool for stroke diagnosis, but it affordability remains an issue for many patients in Uganda. That is why this study was intended to determine the validity of Siriraj Stroke Score (SSS) in differentiating ischemic from haemorrhagic stroke among adult patients admitted with stroke at St Francis Hospital Nsambya, Kampalain order to help for stoke management and therefore reduce complications. Method: A cross-sectional study was conducted among 138 patients aged eighteen years and above, admitted with stroke at St Francis Hospital Nsambya over a period of twelve months. The data was entered and analyzed in the EPI-INFO version 7 and STATA 13 software. SSS was calculated for each patient and the brain CT scan was also taken and analyse. The results of diagnosis made by Siriraj stroke scoring were compiled and compared with the diagnosis obtained by the brain CT scan. All tests were two-sided and the significance level for all the analyses was set to p <0.05. Results: From the 138 patients admitted with Stroke at St Francis Nsambya Hospital, 68.2% (95% CI: 59.7%-75.4%) had Ischemic Stroke, and 31.8% (95% CI: 24.5%-40.2%) had Hemorrhagic stroke, as per the CT scan reports. From Siriraj Stroke Score, most of patients has Ischemic Stroke 45.65% (95% CI: 37.4%-54.1%), followed by those with Hemorrhagicstoke 42.75% (95%CI: 34.6%-51.2%), and 11.6% (95%CI: 7.1%-18.1%) has an uncertain diagnosis of stroke. The sensitivity and the specificity of SSS was found to be respectively 77.2% and 73.4% in diagnosing hemorrhagic stroke and 63.8% and 93.1% in ischemic stroke. Conclusion: The Siriraj Stroke Score was not sufficiently sensitive in differentiating Ischemic from Hemorrhagic among but can be used to determine ischemic stroke. The CT scan should be made affordable and available to all stroke patients in Uganda, and further studies are mandated to provide large data with discriminating variables, to identify a simple clinical scoring that may help to differentiate clinically, the two major stroke types.***

Keywords: Haemorrhagic stroke, Ischemic stroke, Siriraj Stroke Score

1. Background

Worldwide, stroke is the third leading cause of mortality and the most common cause of adult disability (Alan Mozaffarian et al., 2014). In 2010, almost 33 millions of people suffered from stroke (AHA, 2014) . It remains one of the most devastating diseases, causing gross physical impairment and death (Mukherjee and Patil, 2011). According to Hu et al (2007), about 85% of all strokes are ischemic and 15% haemorrhagic (Hu et al., 2007). Haemorrhagic strokes are generally more severe with a considerably higher risk of death when compared with ischemic strokes. Almost 10 to 15% of people with haemorrhagic stroke die before reaching hospital (Abhilash Somasundaran et al., 2017).

In Africa, about 15% of hospital admissions is mainly due to stroke (Etyang A. and Scott, 2013). It is one of the major contributor to mortality in both rural and urban areas (Etyang A. and Scott, 2013). In Uganda, stroke is one of the commonest neurological diseases found among population, up to 3.7% of total admission in hospital is due to stoke (Matovu and Mukisa, 2015). In 2002, WHO estimate that up to 11, 043 deaths due to stroke among Ugandans (WHO, 2009).

The brain CT-scan is the Gold Standard tool in stroke diagnosis; it has to be done early in order to rule out haemorrhagic strokes from ischemic strokes because their managements are completely different and the prognosis depend on the management of the disease (Thijs et al., 2009). So, early, and rapid detection of stroke type is the cornerstone in mitigating the stroke burden and improving it management. However, the cost of brain CT-Scan remains an issue for many patients in Uganda. Moreover, in many treatment facilities especially up-country, it may not be readily available.

For this reason, health care providers may rely on clinical scores, to categorize the type of stroke since CT Scan is not affordable for many patients, especially in public hospital (Nakibuuka, 2012). SSS is one of the clinical stroke scores, which is a simple and reliable bedside method for distinguishing stroke types (Efstathiou et al., 2002).

The validation study of the SSS in African Nigerians showed that the SSS had 92% of sensitivity, a specificity of 94%, a positive predictive value (PPV) of 97%, and a negative predictive value (NPV) of 86% among patients with ischemic stroke.

Among those with haemorrhagic stroke, they validation of SSS found 94% of sensitivity, 92% of specificity, 86% of PPV, and 97% of NPV (Innocent Ijezie et al., 2015).

However, the level of validity of the SSS against the brain CT scan gold standard is yet to be verified in Uganda, where the burden and mortality of stroke seems to be increasing.

This study assessed the validity of SSS in differentiating ischemic from haemorrhagic stroke among adult patients admitted with stroke at St Francis Hospital, Nsambya in order to differentiate the type of stroke earlier and help in the elaboration of best management strategies for secondary prevention and reduction of stroke complications, in Uganda.

2. Methods

2.1. Study setting and Design

A cross sectional study was conducted between November 2017 and December 2018 among patients admitted with stroke on the medical wards at St Francis Hospital Nsambya. This is a private not-for-profit hospital of the Catholic Archdioceses of Kampala. It is one of the largest hospitals in Kampala/Uganda which handles patients with different socio-economic status and from different districts of the country. St Francis Hospital Nsambya in Kampala was selected purposively because it is one of the large hospitals in Kampala, and where all patients admitted with stroke almost invariably do a brain CT scan, the gold standard tool before being admitted.

2.2. Study population

Patients included in the study were those aged18 years and above with clinical features of stroke at admission, with a brain CT scan done confirming stroke type. Patients with brain tumor and trauma were excluded. Patients who died before the Siriraj stroke score and CT scan were done were also excluded from the study.

2.3. Data collection methods

The study protocol followed the guidelines of the Helsinki Declaration of 2013, was approved by the institutional review board (IRB) of St Francis Hospital Nsambya and Uganda Martyr's University, faculty of medicine. The Ethical approval number is ***UG-REC-020***.

A written informed consent was obtained from either each patient himself or the next of kin (if patient was not able to consent), before enrollment in the study. A total of 138 patients were analyzed to address the study objectives.

As part of routine examination, each patient was characterized by its demographic data, past medical history, and clinical symptoms at the admission. For research purposes, the elements of SIRIRAJ score (Level of consciousness, vomiting, diastolic blood pressure, headache, 1 or more features of atheroma: history of Diabetes, claudication, previous ischemic stroke) were added and the type of stroke either ischemic or hemorrhagic from the CT scan were recorded.

2.4. Data analysis

Data were field, edited, coded, cleared and checked for consistency. Coding was performed to clearly identify the required variables for analysis. The data were entered into Epi-Info version 7, transferred to Microsoft Excel 13 for cleaning, and then exported to STATA 13 software for statistical analyses. Summary statistics including frequencies and proportions for categorical variables were performed and means with their standard deviations (SDs) were obtained for continuous variables. For the Screening test, we calculated the sensitivity, the specificity, the PPV and the NPV of SSS using the brain CT scan as the gold standard.

We considered

- True positive for hemorrhagic stroke: all patients qualified with the SSS as having hemorrhagic stroke and the brain CT scan confirmed the same diagnosis.
- False positive for hemorrhagic stroke: all patients fitting under hemorrhagic stroke by SSS but the Brain CT revealed an ischemic stroke.
- True negative for hemorrhagic stroke: all patients with no hemorrhagic stroke (undefined stroke or ischemic stroke) by the SSS and the brain CT confirm the absence of hemorrhage.
- False negative for hemorrhagic stroke: all patients classified as having ischemic stroke or undefined by SSS but the brain CT revealed a hemorrhagic stroke.
- True positive for ischemic stroke: all patients with the SSS of ischemic stroke and the brain CT scan confirmed the same diagnosis.
- False positive for ischemic stroke: patients fitting ischemic stroke by SSS but the Brain CT revealed a hemorrhagic stroke.
- True negative for ischemic stroke: patient with no ischemic stroke (undefined stroke or hemorrhagic stroke) by the SSS and the brain CT confirm the absence of ischemia.
- False negative for hemorrhagic stroke: patients classified as having ischemic stroke or undefined by SSS but the brain CT revealed a hemorrhagic stroke.
- False negative for ischemic stroke: patients classified as having hemorrhagic stroke or undefined by SSS but the brain CT revealed an ischemic stroke.

All tests were two-sided and the significance level for all the analyses was set to $p < 0.05$.

3. Results

3.1. Background and clinical characteristics of participants

From table 1, the mean age (SD) of the respondents was 64.5 years (±16.9).

About 38.4% (53/138) of the study participants had less than 60 years and 61.5% (85/138) had 60 years and above. Results in table 1 show that about 10.8% (15/138) of patient with stroke had a history of a previous stroke event, the majority of participants had a history of hypertension 63.7% (88/138), and the difference of getting either hemorrhagic or Ischemic stroke between patients with history of hypertension and those without history of hypertension was statistically significant (p<0.001).

About 15.9% (22/138) had a history of Diabetes Mellitus. The difference of getting either hemorrhagic or Ischemic stroke between patients with history of Diabetes and those without past history of Diabetes was statistically significant (p=0.04).

The mean duration of hypertension was 5.5 (±7.4) years, and the mean duration of diabetes mellitus was 2 (±5.8) years.

Among participants, history of HIV was only reported by 5.1% (7/138), and the difference of getting either hemorrhagic or Ischemic stroke between patients with history of HIV and those without history of HIV was statistically significant (p=0.02).

About 18.8% (26/138) of participants were taking alcohol regularly, and 2.9% (4/138) were smoking cigarette; only 1.4% (2/138) of patients had a history of claudication.

The mean systolic and diastolic blood pressure were 163.04 (±39.8) and 93.8 (± 25.9) respectively.

From table 1, the majority of patients 42.7% (59/138) were conscious at their admission in the Hospital, and the difference of getting either hemorrhagic between the three group of patients (regarding the Glasgow score) was statistically significant (p<0.001).

Most of the study participants 55.1% (76/138) reported headache, and only 38.4% (53/138) reported a vomiting within the two hours before admission. The difference of getting either hemorrhagic between patients who vomited two hours before admission and those who did not vomited was statistically significant (p<0.001), also the difference of getting either hemorrhagic or ischemic stroke between patients who reported an headache and those who did not was statistically significant (p<0.001).

The mean duration between the first symptom and admission at St Francis Hospital was 38.2 (±51.1) hours, the mean time between admission and CT scan exam was 45.3 (±62.4) and the mean days of patient hospitalization were 7.1 (±9.3) days.

Table 1: Background and clinical characteristics of patients admitted for stroke at St Francis Hospital

Characteristics	Univariate Analysis		
	Men n =63 n (%)	Women n=75 n (%)	Total n=138 n (%)
Age			
<60	25 (39.68)	28 (37.33)	53 (38.41)
≥60	38 (60.32)	47 (62.67)	85 (61.59)
History of previous stroke			
No	57 (90.48)	66 (88.00)	123 (89.13)
Yes	6 (9.52)	9 (12.00)	15 (10.87)
History of hypertension			
No	27 (42.86)	23 (30.67)	50 (36.23)
Yes	36 (57.14)	52 (69.33)	88 (63.77)
History of Diabetes Mellitus			
No	58 (92.06)	58 (77.33)	116 (84.06)
Yes	5 (7.94)	17 (22.67)	22 (15.94)
History of HIV			
No	62 (98.41)	69 (92.00)	131 (94.93)
Yes	1 (1.59)	6 (8.00)	7 (5.07)
History of claudication			
No	62 (98.41)	74 (98.67)	136 (98.55)
Yes	1 (1.59)	1 (1.33)	2 (1.45)
History of alcohol intake			
No	39 (61.90	73 (97.33)	112 (81.16)
Yes	24 (38.10)	2 (2.67)	26 (18.84)
History of smoking			
No	59 (93.65)	75 (100)	134 (97.10)
Yes	4 (6.35)	0 (0)	4 (2.90)
Systolic Blood pressure			
<140	16 (25.40)	22 (29.33)	38 (27.54)
≥140	47 (74.60)	53 (70.67)	100 (72.46)
Diastolic Blood pressure			
<90	26 (41.27)	37 (49.33)	63 (45.65)
≥90	37 (58.7)	38 (50.67)	75 (54.35)
Glasgow score			
Alert	24 (38.10)	35 (46.67)	59 (42.75)
Drowsy & Stupor	25 (39.68)	29 (38.67)	54 (39.13)
Semi Coma	14 (22.22)	11 (14.67)	25 (18.12)
Vomiting			
No	37 (58.73)	48 (64)	85 (61.59)
Yes	26 (41.27)	27 (36)	53 (38.41)
Headache			
No	30 (47.62)	32 (42.67)	62 (44.93)
Yes	33 (52.38)	43 (57.33)	76 (55.07)

3.2. Siriraj stroke score of patients admitted for stroke at St Francis hospital

3.2.1. Stroke type regarding SSS and CT scan

The figure1 shows that from Siriraj Stroke Score, most of patients admitted with stroke at St Francis Hospital, Nsambya, had Ischemic Stroke 45.7% (95% CI: 37.4%-54.1%), followed by those with Hemorrhagic 42.7% (95%CI: 34.6%-51.2%), and 11.6% (95%CI: 7.1%-18.1%) had an uncertain diagnosis. But the difference between men and women, of getting either Hemorrhagic stroke or Ischemic stroke or undetermined diagnosis was not statistically significant (p= 0.53).

From CT scan, 68.2% (95% CI: 59.7%-75.4%) of patients had Ischemic Stroke, and 31.8% (95% CI: 24.5%-40.2%) had Hemorrhagic stroke (see Figure 2). The difference of getting either Hemorrhagic stroke or Ischemic stroke between men and women was statistically significant (p= 0.03).

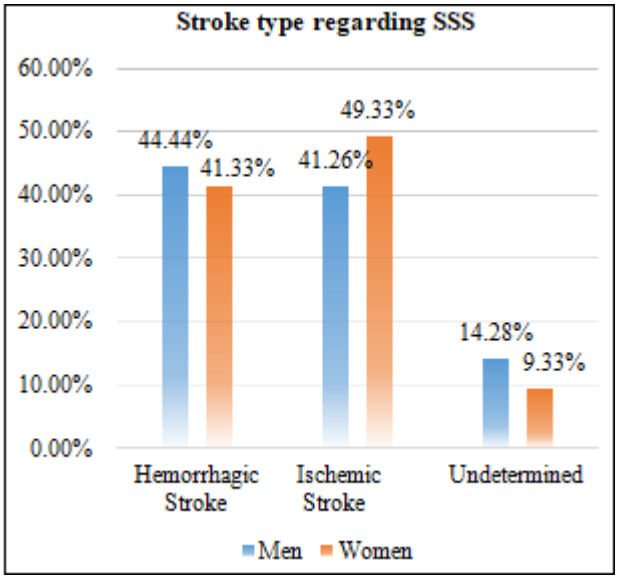

Figure 1: Stroke type regarding SSS

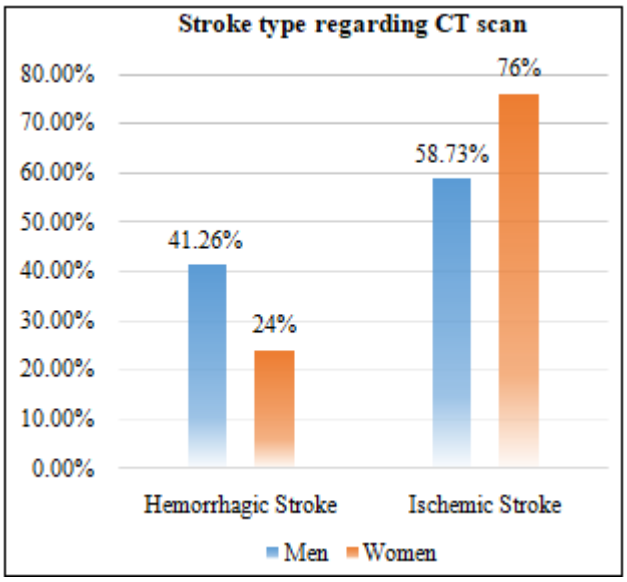

Figure 2: Stroke type regarding CT scan

3.2.2. Validity of SSS

a) For Ischemic Stroke

Considering ischemic stroke, and when we compare the Siriraj stroke score to CT scan, the figure 1 shows that 63.8% of patient with ischemic stroke by Siriraj Stroke Score will also be positive for ischemic stroke by CT scan, meaning 63.8% of patient with ischemic stroke are correctly identified as such, when using the SSS. And 93.1% of patient without ischemic stroke at CT scan will test negative, when using the SSS. (Table 2)

About 95.2% of patients admitted for ischemic stroke at St Francis Hospital, after using SSS, actually had ischemic stroke, and 87.3 % of stroke patients admitted for other type than ischemic, actually don't have it. (Table 2)

Table 2: Validity of SSS for Ischemic stroke at St Francis Hospital

Siriraj Stroke Score	Gold Standard CT Scan		Sensitivity 95% CI	Specificity 95% CI
	Ischemic Stroke	No Ischemic Stroke		
Ischemic Stroke	60 TP	3 FP	63.87% (95%CI 53.27-73.49)	93.1% (95%CI 81.34-98.57)
No Ischemic Stroke	34 FN	41 TN		

TP: True Positive FN: False Negative FP: False Positive TN: True Negative

b) For Hemorrhagic Stroke

When we compare the Siriraj stroke score to CT scan, the table 3shows that patient with hemorrhagic stroke has 77.2% chance of having Hemorrhagic stroke when using SSS that means 77.2% of patient with hemorrhagic stroke are correctly identify as such, when using the SSS. When using SSS, 73.4% of patient without hemorrhagic stroke at CT scan will test negative. About 57.6 % of patients admitted for Hemorrhagic stroke at St Francis Hospital, actually had it, after using SSS, and 54.6 % of stroke patients admitted for other type than hemorrhagic stroke, actually do not have it.

Table 3: Validity of SSS for Hemorrhagic Stroke at St Francis Hospital

Siriraj Stroke Score	Gold Standard CT Scan		Sensitivity 95% CI	Specificity 95% CI
	Hemorrhagic Stroke	No Hemorrhagic Stroke		
Hemorrhagic Stroke	34 TP	25 FP	77.27% (95%CI 62.15-88.52)	73.40% (63.29-81.99%)
No Hemorrhagic stroke	10 FN	69 TN		

TP: True Positive FN: False Negative FP: False Positive TN: True Negative

4. Discussion

In Uganda, stroke is one of the common neurological diseases found among population. From this study the majority of patients admitted with stroke at St Francis Hospital, Nsambya had Ischemic Stroke when compare to those with Hemorrhagic stroke (see figure 2). This is similar to previous studies done in Uganda (Matovu and Mukisa, 2015, Nakibuuka, 2012) , Nigeria (Innocent Ijezie et al., 2015, Obiako et al., 2011) , India (Singh H et al., 2001, Pavan Manibettu et al., 2012) and in Brazil (Fernandes et al., 2012, Minelli et al., 2007) , where the majority of patients

with stroke had ischemic stroke. This study results was also consistent with a population based study for some European countries and USA, reported in a systematic review (Feigin VL et al., 2009).

According to the American Heart association, Ischemic stroke occurs as a result of an obstruction within a blood vessel supplying blood to the brain, yet Hemorrhagic stroke occurs when a weakened blood vessels ruptures (AHA, 2014). The Ischemic stroke can be find in the majority of patient because it is mostly due to clots which are thrombi or atheroma or plaques from atherosclerosis (Randolph, 2012). And nowadays with the increase of non-communicable diseases risks factors in population, the atherosclerosis seems to be more prevalent, also according to the Heart Research Institute the risk of developing serious atherosclerosis increases with age, yet the majority of our study population has more than 60 years.

When we compare the Siriraj stroke score to CT scan, this study found that the sensitivity of Ischemic and Hemorrhagic stroke wasn't high. This was similar with a study done by Hawkins GC et al who reported a sensitivity of 61% for ischemic stroke (Hawkins GC et al., 1995). It was a bit similar with a study done by Celani MG et al, which found that the sensitivity of SSS for detecting Hemorrhagic Stroke was 61% (Celani et al., 1994) and the study done by Innocent Idjezie et al, among Nigerian with a sensitivity of 71% for Ischemic Stroke (Innocent Ijezie et al., 2015). That was a bit consistent also with a studies done in Pakistan, where of the 100 cases studied by Shah FU et al, the sensitivity of SSS for ischemic stroke was 71% and for hemorrhagic stroke, it was 73% (Shah FU et al., 2003).

The results of this study were a bit different of other studies done in Nigeria by Salawu et al (Salawu F et al., 2009) that found the sensitivity of 35 % in detecting hemorrhagic stroke. Another study done in India (Wadhawani J et al., 2002) found a sensitivity of 89% for hemorrhagic stroke and 93% for ischemic stroke. And the sensitivity of SSS in detecting hemorrhagic and Ischemic stroke was 36% and 90% respectively in USA according to Akpunonu et al. (Akpunonu BE et al., 1998).

In this study the specificity of SSS for ischemic and hemorrhagic stroke was respectively 93.1% and 73.4%. That was different with a study done in Nepal with a specificity of 67% for both hemorrhagic and ischemic stroke (Rajouria AD et al., 2012). The study findings was similar with a study done in Southwest Nigeria for ischemic stroke with a specificity of 91% but different when it comes to hemorrhagic with a specificity of 63% (Kehinde O. Kolapo et al., 2006). The same tendency was noted in a study done in Southeast Nigeria with the similarity of Ischemic specificity and difference when comparing Hemorrhagic specificities with 94% and 92% respectively (Innocent Ijezie et al., 2015). This results can be explain by the similarity of socio-demographic and economic status among African population,

According to this study findings, the SSS is not sensitive enough to differentiate Ischemic from Hemorrhagic stroke among Ugandans; it may not be accurate in guiding the diagnosis of the two types of strokes, but may be used in detecting ischemique stoke.

Further studies must be done with large sample size and discriminating variables, to identify a simple clinical scoring that may help to differentiate clinically, the two stroke types among Ugandans. And if possible, CT scan which remains the gold standard investigation technique of stroke type should be made affordable and available for all patients.

5. Study Limitations and Strengths

This is among the first studies done in Uganda trying to assess the accuracy of Siriraj Stroke Score in Stroke patients. With different values mentioned above clinicians have an idea of how accurate is the test when managing a patient with stroke when the CT scan is not available.

A recall bias could have occurred as some data, especially from the questionnaire, were self-reported by the patient or the attendant. A social desirability bias that could have occurred since in the study, most of information was reported by participants.

6. Conclusion and Recommendations

The Siriraj Stroke Score is not sensitive enough to differentiate Ischemic from Hemorrhagic among Ugandans, but can be used to detect ischemique stroke. The use of the CT scan which remain the gold standard investigation technic of stroke type should be made affordable and available for all the majority of patients in Uganda. Despite the low sensitivity of SSS in detecting the type of stroke; it can still be used in setting without CT Scan, as the specificity of detecting ischemic stroke is high. Further studies must be done with large sample and discriminating variables, to identify a simple clinical scoring that may help to differentiate clinically, the two stroke types among Ugandans.

Acronyms and Abbreviations

AHA: American Heart Association
ASS: Allen Stroke Score
CT scan: Computerized Tomography
HIV: Human Immunodeficiency Virus
LMIC: Low and middle Income country
MRI: Magnetic Resonance Imaging
NPV: Negative predictive value
PPV: Positive predictive value
SSS: Siriraj Stroke Score
SSNAP: Sentinel Stroke National Audit Program
TIA: Transient Ischemic Attack
TB: Tuberculosis
UTI: Urinary Tract Infection
WHO: World Health Organisation

Declarations

Ethical approval and consent to participate

The study was conducted after obtaining ethical clearance from Institutional Review Board of Saint Francis Hospital,

Nsambya. The discretion and the confidentiality of patients' information was assured and each patient included in the study signed the consent form or the next of kin if patient unable to consent.

Consent for publication

Not applicable

Availability of data and materials

The dataset used and analysed during this study is available from the corresponding author.

Competing interests

The authors declare that they have no competing interests.

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Not applicable

Authors' contributions

DAVID SALAMA KAISHUSHA is the lead author of the manuscript. He formulated the concept, supervised all stages of the study and the manuscript writing.

INGABIRE PROSSIE and SYLVESTER SSEMANDA supervised the data collection.

MAKI SIFA SALAMA performed statistical analysis.

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EDDUARD DUMBA

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