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Determinants of survival time for HIV/AIDS patients in the pastoralist region of Borena: a study at Yabelo General Hospital, South East Ethiopia

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Abstract

Introduction HIV/AIDS is one of the most dangerous diseases globally, impacting public health, economics, society, political issues, and communities. As of 2023, the World Health Organization estimates that 40.4 million people are living with HIV/AIDS. This study aimed to identify the determinants of survival time for HIV/AIDS patients in the pastoralist region of Borena at Yabelo General Hospital.

Method The study design was a retrospective cohort study, with a sample size of 293 individuals living with HIV/AIDS, based on recorded data. This research utilized survival model analysis, employing Kaplan-Meier plots, the log-rank test, and Cox proportional hazard model analysis.

Result Out of the total sample size, 179 (61.1%) were female and 114 (38.1%) were male. Among these males, 36 (31.6%) were deceased. The analysis using the Cox proportional hazard model revealed that the following variables were significantly associated with the survival time of HIV/AIDS patients: gender, educational status, area of residence, tuberculosis (TB), and opportunistic infections.

Conclusions We concluded that individuals living with HIV/AIDS in urban areas have a lower risk of death compared to those in rural areas, indicating that rural residents have a reduced survival probability. Therefore, the Borena zone administration should focus on adult patients to enhance life expectancy.

Keywords Borena, Cox PH, HIV/AIDS, Survival time, Yabelo General Hospital

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Background

The human immunodeficiency virus (HIV) is the world's most critical public health issue. According to estimates from the World Health Organization, approximately 40.4 million people were living with HIV by mid-2023. In the African region, an estimated 25.6 million individuals had HIV by that time, as reported by the WHO. In 2022, over 20.9 million people received antiretroviral treatment. That same year, an estimated 660,000 individuals acquired HIV, and by mid-2023, the rate of new HIV infections across all ages had decreased to 0.57 per 1,000, although the uninfected population had declined from 1.75 in 2010 [1].

Survival patterns among African communities following HIV infection before the introduction of ART served as an initial benchmark for assessing the future viability of intervention initiatives [2]. Since the advent of antiretroviral therapy (ART), HIV infection has transitioned from a severe condition to a chronic illness [3]. In Ethiopia, current estimates indicate a slight decline in PLWH, from 610,350 in 2022 to 603,537 in 2023. Reported prevalence shows that the number of PLHIV in the Oromia region gradually decreased, from 158,152 in 2022 to 156,184 in 2023 [4].

The Borena community pastoralists have long existed under the Gada society's cultural, social, community, and political organization, led by the Abba Gada or elders of Borena. Following 1950, the modern education system in Borena began, but the Gada system's structure has been in place since around the 14th century, resulting in a lack of contemporary education. According to a report from the Ethiopia Public Health Institute [5], 2,600 adult Borena individuals are living with HIV infection, indicating that many pastoralists remain unaware of disease transmission. This vulnerability to the disease is prevalent throughout all areas of the Borena pastoralist community. Consequently, numerous individuals have been infected, primarily due to insufficient protective measures and insufficient education.

In addition, concurrent extramarital sexual activities, polygamy, and marrying a deceased wife's sister have been identified as risk factors for HIV infection. Although not extensively documented, the practice of maintaining extramarital sexual partners by both men and women, widow inheritance, and polygamy appears to have decreased, although it continues to occur in secret [6, 7]. Despite the lack of studies on vulnerability within the Borana population, a few behavioral and biological studies indicate a very high HIV prevalence in the region compared to similar contexts [8, 9]. The researcher aimed to determine the survival time for HIV/AIDS patients in the pastoralist region of Borena at Yabelo General Hospital from January 2016 to December 2019. The results will provide information about the determinants of survival time for people living with HIV/AIDS in the pastoralist region of Borena.

Methods and materials

Study area

The study was conducted at Yabelo General Hospital, situated in Yabelo town, Borena Zone. This zone is one of twenty-one zones in the Oromia Region. In 2010, the hospital was upgraded from a Health Center to a general hospital. It provides various services to the residents of Borena Zone and other Ethiopian ethnic groups. Currently, the zone comprises ten rural pastoralist woredas and one town administration, Yabelo, which has a state function. The zone is located in the southern part of the Oromia region. It shares borders with the West Guji Zone to the north, the South Nations, Nationalities, and Peoples region to the west, the Somali region to the southeast, and an international boundary with Kenya to the south (as shown in the geographical map below, Fig. 1).

According to the 2023 report from the Borena Zone Administration Office, over 1.4 million people reside in the zone, with a male-to-female ratio of 1:1. This suggests significant variation in settlement patterns from district to district. Approximately 89% of the population inhabits the rural pastoralist areas of the zone [10]. The Borana Zone is one of the most pastoralist regions in Ethiopia, primarily relying on livestock rearing. The livestock population in Borena includes 1,482,053 goats, 1,179,645 sheep, 637,632 horses, 2,222 mules, 5,525 donkeys, 68,799 camels, and 185,382 cattle [11].

Source of data and study population

The study is a retrospective cohort analysis, indicating that all events and exposures detailed in the review subjects' patient cards and information sheets occurred in the past. All individuals diagnosed with HIV at Yabelo General Hospital and receiving ART were included in the study at regular intervals. Based on the inclusion and exclusion criteria, 293 adult HIV/AIDS patients were selected from their medical records. Participants in this study were HIV-positive individuals receiving follow-up antiretroviral therapy during the study intervals. This study encompassed all adult HIV-positive patients who visited the hospital for treatment three or more times, as well as adult HIV/AIDS patients who initiated treatment between January 2016 and December 2019. According to hospital records, 1,147 HIV patients underwent ART treatment and were assessed for baseline CD4 count cells during the study periods.

Sample size determination

The researcher was able to obtain statistically significant results by employing the formula for calculating the

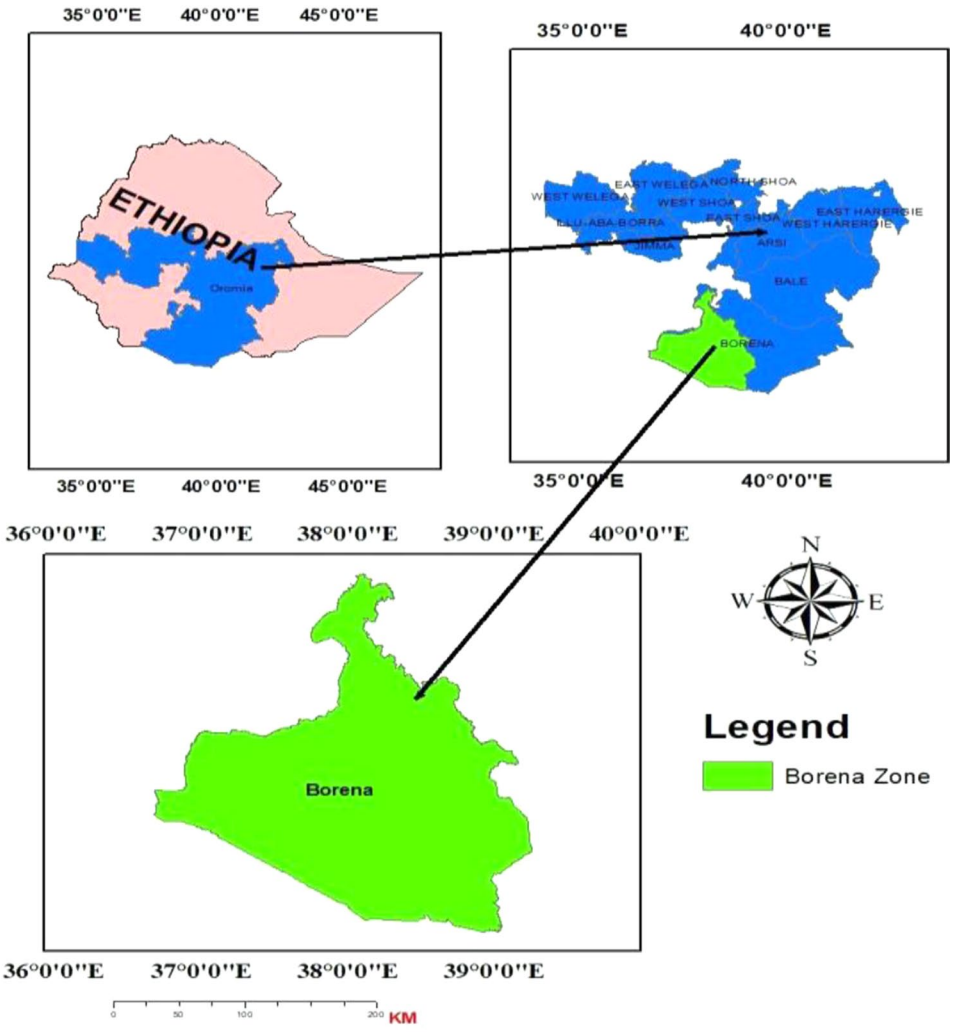

Fig. 1 Map of Borena zone

required sample size [12]. According to [13], the sample size was determined by analyzing the mortality rates in two groups of HIV-positive individuals on ART, categorized by their WHO clinical stage as exposure status. Consequently, the sample size for this current study has reached 293 HIV/AIDS-positive subjects, taking into account the inclusion criteria (further calculations are available in the supplementary material).

Variables of the study

The outcome variable for survival analysis is the survival time and/or time to death of patients under follow-up among HIV-infected adults. The predictors included in this study were gender, age, marital status, educational status, place of residence, WHO stages, TB, adherence to ART treatment, functional status, family history, and opportunistic infectious diseases.

WHO stages

These are the clinical stages of patients based on CD4 values, classified into four stages: stage I, stage II, stage III, and stage IV.

Tuberculosis (TB)

Individuals with HIV and weakened immune systems are at a higher risk of contracting tuberculosis compared to those with typical immune systems.

Family History

This refers to the previous occurrences of HIV/AIDS disease or past incidences among family members.

Opportunistic infectious diseases

These are infections that occur more frequently and are more severe in individuals with declining immune systems.

Functional status

Working: able to perform usual work in or out of the house; Ambulatory: able to carry out activities of daily living; Bedridden: unable to perform activities of daily living [14].

Adherence

Adherence was categorized as good if patients adhered to at least 95% of the prescribed medication, fair if they adhered between 85% and 95%, and poor if they adhered to less than 85% of the prescribed medication [15].

Method of analysis

The analysis was conducted using R software version 4.3.1. It includes descriptive statistics of variables, the Kaplan-Meier method, the log-rank test, and the Cox proportional hazards model for the time-to-event data from the survival datasets.

Survival analysis model

Survival analysis is a branch of statistics that investigates the anticipated duration until one or more events take place [16]. This data shows that not all patients experience the event by the conclusion of the observation period; thus, the actual survival times for some individuals living with HIV/AIDS remain unknown, a phenomenon referred to as censoring, which must be accounted for in the study to yield meaningful results [17, 18].

Kaplan - Meier estimator

The Kaplan-Meier estimator [19] provides a non-parametric maximum likelihood estimate of the survival function.

Cox proportional hazards model

The basic model for survival analysis is investigated under the Cox proportional hazard model, a model originated by Cox [16]. In a model, the unique effect of a unit increase in a covariate is multiplicative in terms of the hazard rate. Its covariates can be time-independent. This model implies that the hazard function λ (t, X,)β is connected to the covariates as a product of a baseline hazard $\lambda_0(t)$ and a function of covariates.

Results

In this study, records of 293 individuals living with HIV/AIDS were included; of this total, 179 (61.1%) were female. Among these females, 33 (18.4%) had died, while the others were censored. Among the male patients, 36 (31.6%) were deceased. Of the total samples, 83 (28.3%) were related to tuberculosis. Among the tuberculosis (TB) patients, 34 (41.0%) died, whereas 35 (16.7%) of the non-tuberculosis patients died. Regarding functional status, 221 (75.4%) of the patients were working, 27 (9.2%) were bedridden, and 45 (15.4%) were ambulatory. Among those who were working, 50 (22.6%) patients died.

In the baseline test results, 201 (68.6%) of the patients had no family members related to this disease (none related to HIV/AIDS previously), while the remaining 92 (31.4%) were suffering from opportunistic infections of another disease, with 35 (38.0%) of these patients having died from their opportunistic infections (Table 1).

Survival analysis

Comparison of survival grouped data

The survival data for these studies consists of baseline information extracted from the entire sample patient set. The significant difference in group variables was determined using Kaplan-Meier plots and a log-rank test. Figure 2 below illustrates a significant difference between the categorical groups, as shown in the Kaplan-Meier plot. Female patients had slightly higher survival rates than males from the beginning to the end. Based on place of residence, patients from urban areas exhibited a higher survival probability than those from rural areas regarding survival time. The log-rank test for these variables indicates a statistically significant difference between patients from urban areas and those from rural areas (Supplementary Table 1).

When comparing the different educational statuses of patients, a Kaplan-Meier plot for this variable is presented in Fig. 2. It is evident that there is no significant difference between the groups in the plot. In comparing the categories, primary and secondary education displayed similar patterns, while not formally educated and tertiary groups also showed similar trends, though not statistically supported. A statistical test using the log-rank method reveals a statistically significant difference ($P=0.02$) among not formally educated, primary, secondary, and tertiary groups concerning survival time in months.

Among tuberculosis (TB) patients, the Kaplan-Meier estimate plot indicates that individuals living with HIV/AIDS who did not have TB were more likely to survive than those who had TB, in terms of survival time in months. The log-rank test for these variables also demonstrates a statistically significant difference between patients with TB and those without (Supplementary Table 1).

Assumption checking

The results of the covariates and the global test for the proportionality assumption of the Cox proportional hazards model are presented. The p-values for the covariate terms and the global test are insignificant at the 5% level, indicating that the proportional hazards assumptions are not violated. In the Schoenfeld residual plot, no patterns are observed between the variables and time. The

Table 1 Baseline categorical variables of the Survival Status HIV/AIDS patients in Yabelo General Hospital from January 2016 to December 2019

Variables	Category	Censoring Status		Number Out of Total (%)
		Censored (%)	Death (%)	
Gender	Male	78 (68.4)	36 (31.6)	114 (38.9)
	Female	146 (81.6)	33 (18.4)	179 (61.1)
Marital Status	Single	29 (69.0)	13 (31.0)	42 (14.3)
	Married	105 (75.5)	34 (24.5)	139 (47.4)
	Widow	55 (85.9)	9 (14.1)	64 (21.8)
	Divorced	35 (72.9)	13 (27.1)	48 (16.4)
Educational	Not Formal	101 (69.2)	45 (30.8)	146 (49.8)
	Primary	71 (84.5)	13 (15.5)	84 (28.7)
	Secondary	33 (89.2)	4 (10.8)	37 (12.6)
	Tertiary	19 (73.1)	7 (26.9)	26 (8.9)
WHO Stage	Stage I	125 (77.2)	37 (22.8)	162 (55.3)
	Stage II	31 (86.1)	5 (13.9)	36 (12.3)
	Stage III	57 (75.0)	19 (25.0)	76 (25.9)
	Stage IV	11 (57.9)	8 (42.1)	19 (6.5)
Residence	Urban	147 (84.5)	27 (15.5)	174 (59.4)
	Rural	77 (64.7)	42 (35.3)	119 (40.6)
TB	No	175 (83.3)	35 (16.7)	210 (71.7)
	Yes	49 (59.0)	34 (41.0)	83 (28.3)
Adherence	Good	142 (77.2)	42 (22.8)	184 (62.8)
	Poor	64 (77.1)	19 (22.9)	83 (28.3)
	Fair	18 (69.2)	8 (30.8)	26 (8.9)
Functional Status	Ambulatory	33 (73.3)	12 (26.7)	45 (15.4)
	Bedridden	20 (74.1)	7 (25.9)	27 (9.2)
	Working	171 (77.4)	50 (22.6)	221 (75.4)
Specimen Type	Whole type	44 (77.2)	13 (22.8)	57 (19.5)
	Plasma	154 (75.9)	49 (24.1)	203 (69.3)
	DBS	26 (78.8)	7 (21.2)	33 (11.3)
Family History	No	158 (83.2)	32 (16.8)	190 (64.8)
	Yes	66 (64.1)	37 (35.9)	103 (35.2)
Opportunistic Infections Disease	No	167 (83.1)	34 (16.9)	201 (68.6)
	Yes	57 (62.0)	35 (38.0)	92 (31.4)

assumption of proportional hazards has been satisfied for both methods (Supplementary Tables 2 and Supplementary Fig. 1).

Multivariate analysis of the Cox-PH model

Variables such as gender, educational status, place of residence, tuberculosis, family history, and opportunistic infections were significantly associated with the survival time of adults living with HIV/AIDS undergoing ART treatment at the 5% level of significance. According to the adjusted hazard ratio, male HIV-infected patients were 1.69 times more likely to die than their female counterparts (HR=1.69, p-value=0.036). This indicates that male patients faced a 69% higher risk of experiencing an event compared to female patients (Table 2).

It has been estimated that patients educated at the secondary level have a hazard rate of 0.31, indicating a 0.31-fold lower risk of death compared to non-formally educated patients (HR=0.31, p-value=0.028). There was a 1.72 times greater mortality risk for HIV-infected adults with TB compared to those without TB. The results indicate that 72% of TB patients face an increased risk of death compared to those without TB.

Regarding the family history of HIV patients, families with a history of the disease were at 1.66 times higher risk of death than those without a family history of HIV/AIDS (HR=1.66, p-value=0.047). Concerning opportunistic infections, patients with a risk of opportunistic infections had a 2.30 times higher risk of death than patients without such a risk (HR=2.30, p-value=0.002). However, marital status and WHO stages do not significantly affect the survival time to death in HIV patients.

Discussions

This study aimed to identify factors affecting the survival time of adult HIV/AIDS patients in the pastoralist area of Borena at Yabelo General Hospital from January 2016 to December 2019. In the current study, the gender variable

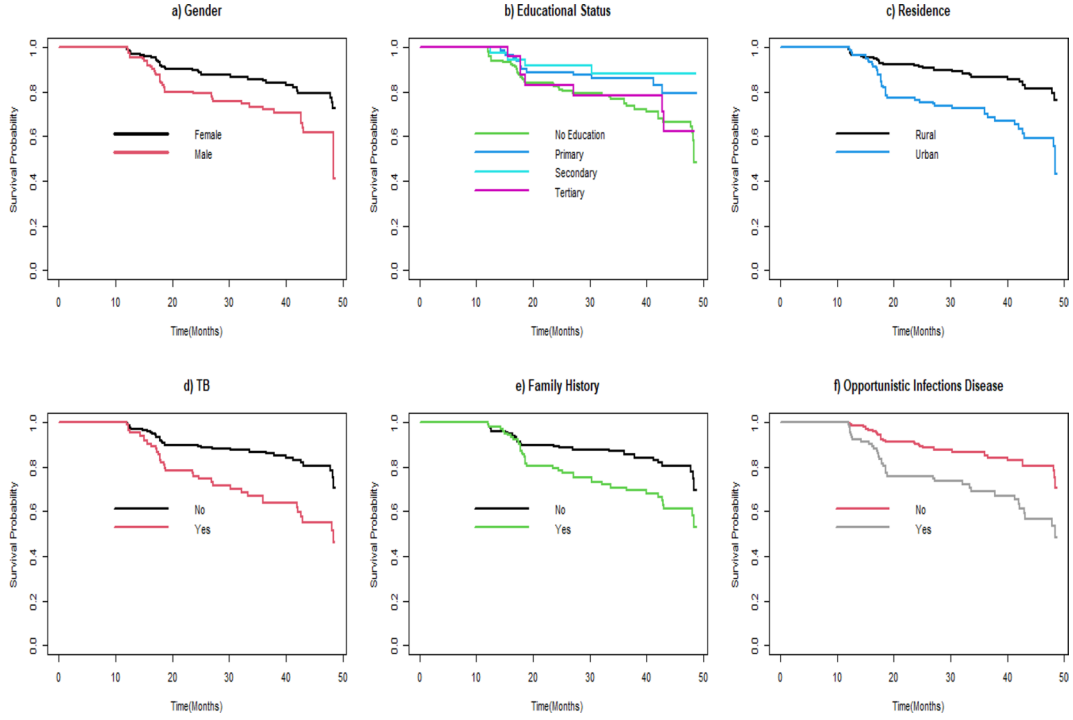

Fig. 2 Kaplan-Meier plots of different categorical variables

Table 2 Parameter estimation results for adult HIV/AIDS patients data, in Yabelo general hospital using cox regression model

Variables	Category	Crude HR (95% CI)	*P*-value	Adjusted HR (95% CI)	*P*-value
Gender	Female	1			
	Male	1.97 (1.23, 3.16)	0.005	1.69 [1.03, 2.78]	0.036*
Educational	Not formal	1			
	Primary	0.48 (0.26, 0.89)	0.02	0.53 [0.28, 1.02]	0.058
	Secondary	0.30 (0.11, 0.83)	0.02	0.31 [0.11, 0.88]	0.028*
	Tertiary	0.87 (0.38, 1.92)	0.722	0.72 [0.31, 1.64]	0.428
Residence	Rural	1			
	Urban	0.38(0.24, 0.62)	0.00	0.46 [0.27, 0.76]	0.002*
TB	No	1			
	Yes	2.53 (1.58, 4.07)	0.00	1.72 [1.04, 2.85]	0.035*
Family History	No	1			
	Yes	2.02 (1.26, 3.24)	0.003	1.67 [1.01, 2.75]	0.047*
Opportunistic infection	No	1			
	Yes	2.38 (1.49, 3.82)	0.00	2.30 [1.36, 3.91]	0.002*

* significant ,**CI**: Confidence interval, **HR**: Hazard ratio

is significantly associated with survival time until death, consistent with several other studies [20–22]. The mortality risk for adult male patients was higher than that for adult female patients, suggesting that female patients are more likely to know their HIV status at an earlier stage and to start ART with higher CD4 counts than males [20]. According to other studies, gender status was not associated with survival time until HIV/AIDS-related risks [23–26].

The findings of this study revealed that individuals living with HIV/AIDS who had a secondary educational status had a lower hazard ratio of death than those with no formal education. Various studies supported the notion that secondary educational status was linked to a lower risk of mortality among HIV-infected antiretroviral therapy users, indicating significant effects on the survival time of adult patients [25, 27–31].

A patient living in urban areas has a 0.46 times lower death rate than a patient living in rural areas, indicating that patients from urban areas are more likely to survive than those in rural regions. Similarly, the study at Debre Tabor Referral Hospital suggests that patients in urban areas had significantly higher survival rates compared to those from rural areas [32]. In a study examining the

impact of the "universal test and treat" program on HIV treatment in the Gurage Zone, it was found that rural patients had significantly better survival rates than urban patients [33]. Possible reasons include better drug adherence, improved access to services, closer proximity to health centers, superior care provided, and varying levels of knowledge.

According to the findings of this study, patients with tuberculosis (TB) and HIV faced 1.72 times the risk of dying from the disease compared to patients without TB. Therefore, patients without coinfection diseases have a better survival rate than those with them. A similar study conducted at Goba Hospital in Southeast Ethiopia found that TB coinfection at the start of ART was strongly associated with increased mortality risks among ART patients [26, 33]. However, other study results did not demonstrate any association between baseline TB infection and the death hazard rate [23].

People living with HIV/AIDS who have opportunistic infections are linked to an increase in HIV-infected patients, according to our study. It has been estimated that patients with opportunistic infections alongside other diseases face a higher risk of death compared to those without such infections. Various studies support the notion that opportunistic infections are significantly associated with the survival and mortality of HIV-infected patients [23, 25].

Conclusions

The main objective of this study was to determine the survival time for HIV/AIDS patients in the pastoralist region of Borena at Yabelo General Hospital from January 2016 to December 2019. In this study, a total of 293 adults living with HIV/AIDS were analyzed. According to the Cox-PH model, covariates such as gender, educational status, place of residence, TB, family history, and opportunistic infections were identified as factors affecting the survival time of HIV-infected individuals. Patients residing in urban areas have a lower risk of death than those living in rural areas, indicating that rural patients have a lower survival probability compared to their urban counterparts. Therefore, the Borena zone administration should pay special attention to adult patients to enhance life expectancy.

Abbreviations

EPHI	Ethiopian Public Health Institute
PH	Proportional Hazard
TB	Tuberculosis
UNAIDS	Joint United Nations Programme on HIV/AIDS
WHO	World Health Organization

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Author contributions

Conceptualization: Galgalo Jaba Nura, Markos Abiso Erango.Data curation: Galgalo Jaba Nura, Kumbi Sara Wario. Formal analysis: Galgalo Jaba Nura. Investigation: Galgalo Jaba Nura, Kumbi Sara Wario, Markos Abiso Erango. Methodology: Galgalo Jaba Nura, Markos Abiso Erango.Project administration: Markos Abiso Erango.Software: Galgalo Jaba Nura, Markos Abiso Erango. Supervision: Markos Abiso Erango.Validation: Markos Abiso Erango. Writing – original draft: Kumbi Sara Wario, Markos Abiso Erango. Writing – review & editing: Kumbi Sara Wario, Markos Abiso Erango.

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Data availability

after getting acceptance.

Declarations

Competing interests

The authors declare no competing interests.

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