



## Research article

## Prevalence and factors associated with preoperative anemia among adult patients scheduled for major elective surgery at University hospital in Northwest Ethiopia; a cross-sectional study

Amare Anley Beyable<sup>a</sup>, Yophtahe Woldegerima Berhe<sup>b,\*</sup>, Yonas Addisu Nigatu<sup>b</sup>, Hailu Yimer Tawuye<sup>b</sup><sup>a</sup> Department of Anesthesia, College of Medicine and Health Sciences, Debre-Markos University, Debre-Markos, Ethiopia<sup>b</sup> Department of Anesthesia, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia

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## ABSTRACT

**Background:** Anemia is the most common hematological finding in surgical patients. One-third of surgical patients were anemic during preoperative assessment. The presence of preoperative anemia was found to be related with increased morbidity, mortality, length of hospital stay, intensive care unit admissions and postoperative infections.**Objective:** To determine the prevalence and factors associated with preoperative anemia among adult patients scheduled for major elective surgery at University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia, 2020.**Methods:** After obtaining an ethical approval, hospital-based cross-sectional quantitative study was conducted from June to August 2020 in University of Gondar Hospital. Full blood count within two weeks of preoperative period was considered valid if there were no any factors that affect the hematologic system. Descriptive statistics, cross-tabulations and binary logistic regression analysis were performed to identify factors associated with preoperative anemia. The strength of the association was presented using AOR with 95% confidence interval and p-value < 0.05 was considered as statistically significant.**Result:** A total of 185 patients enrolled with 100% response rate. We observed preoperative anemia in 36.8% patients. The multi-variable binary logistic analysis showed that ASA II and III [AOR: 3.8, CI: 1.6–9.2], recent prior surgery [AOR: 3.3, CI: 1.3–8.5], history of malignancy [AOR: 9.4, CI: 2.0–43.4], orthopedic procedure [AOR: 11.2, CI: 4.0–31.6] and gynecologic procedure [AOR: 5.2, CI: 1.7–14.5] were significantly associated with preoperative anemia.**Conclusion:** The prevalence of preoperative anemia was high and ASA  $\geq 2$ , recent prior surgery, history of malignancy, orthopedic surgery and gynecologic procedure were significantly associated with preoperative anemia. We recommend to clinicians to aim prevention, early detection and treatment of preoperative anemia among adult patients scheduled for major elective surgery to reduce risk of anemia and related adverse outcomes.

## 1. Introduction

Anemia is the commonest hematological disorder affecting almost one-third of the global population with major consequences for human health [1, 2, 3]. According to World Health Organization (WHO) criteria, the global prevalence of anemia in 2010 was 32.9% [4] and in Ethiopia, it was around 23% in women and 10–26% in men [5]. The predominant burden of anemia is found in low and middle income countries. The WHO reported that 97% anemic population lives in these countries and half of

this burden was caused by iron deficiency anemia [6, 7]. This public health burden can be explained by poor intake of iron, intestinal parasitic infestations and high prevalence of malaria and human immunodeficiency (HIV) virus infections [8, 9]. The previous studies have revealed wide ranges of the prevalence of anemia among surgical patients. Preoperative anemia was found in 5–78% of patients who were scheduled for surgical interventions [10, 11], and in 30–60% of patients who were scheduled for major elective surgery [12]. Even, higher rates among colorectal cancer and gynecological and major orthopedic patients [13].

\* Corresponding author.

E-mail address: [yophtii@gmail.com](mailto:yophtii@gmail.com) (Y.W. Berhe).<https://doi.org/10.1016/j.heliyon.2022.e08921>

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The commonest causes of preoperative anemia are hospital acquired anemia, iron deficiency anemia, and anemia of chronic illness [11]. The presence of anemia in surgical patient is associated with adverse clinical outcomes [14]. It carries several perioperative risks including increased morbidity, mortality, requirements of allogeneic blood transfusion, postoperative infections, intensive care unit admissions, length of hospital stay, readmission and reoperation rates. Preoperative anemia is an independent factor associated with perioperative stroke, heart failure, arrhythmias, renal impairment, and death in patients that undergone both cardiac and non-cardiac surgery [13, 15, 16, 17, 18, 19, 20, 21]. All of these negative impacts of preoperative anemia have huge cost implications especially for developing countries. The economic loss of iron deficiency anemia alone was 4% of gross domestic product in these countries [7]. Hence, early diagnosis and appropriate preoperative optimization of anemic surgical patients is very important [16, 18, 22].

The prevalence of preoperative anemia varies according to age, gender, anthropometric and nutritional factors, socioeconomic status, surgical conditions, recent prior surgery, comorbidities, medications and criteria used to define anemia [4, 10, 22, 23]. The presence of wide ranges of results among previous studies, lack of well emerged evidences in the study area and the country at large, the high prevalence of conditions that can exaggerate preoperative anemia such as malnutrition, chronic diseases, diseases of poor hygiene, and poor economic status in the study area had triggered us to conduct the current study and determine the magnitude of the problem and conditions that affect the problem. Hence, the objective of this study was to determine the prevalence and factors associated with preoperative anemia among adult patients scheduled for major elective surgery at University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia, 2020.

## 2. Methodology

Hospital-based cross-sectional study was conducted from June 30 to August 30, 2020 at the University of Gondar Comprehensive Specialized Hospital (UoGCSH). The hospital is located in Gondar town, Northwest Ethiopia. The source population was all adult patients scheduled for major surgical procedures and the study population was all the consecutive adult (15+) patients scheduled for major elective surgery during the study period at UoGCSH. Obstetric patients, known anemic patients who were on treatment, patients with cognitive dysfunction, and patients who came for day case surgery were excluded from this study.

The dependent variable was the presence of preoperative anemia and independent variables were socio-economic and demographic variables (age, sex, BMI, ASA status, educational status, occupation, residence), surgical conditions (Trauma, urologic, orthopedic, gynecologic, and recent prior surgery), comorbidity (peptic ulceration, myocardial infarction, hypertension, HIV, malaria, diabetes mellitus, malignancy, asthma, and renal disease), medications (chronic use of non-steroidal anti-inflammatory drugs (NSAID), antiretroviral therapy, and chemotherapy drugs).

### 2.1. Operational definitions

**Anemia:** hemoglobin level <12 g/dl for females and <13 g/dl for males, in accordance to the guideline by World Health Organization [13].

**Mild anemia:** hemoglobin measurements between 11 – 11.9 g/dl for females and 11–12.9 g/dl for males [24].

**Moderate and severe anemia:** hemoglobin measurements less than 8 g/dl females and 8–10.9 g/dl for males [24, 25].

**Adult patient:** patient with the age of 15 years and above for both genders [16, 26].

**Major surgery:** any invasive operative procedure in which mesenchymal barrier opened, anticipated surgical duration was more than 1 h and more prone to serious perioperative complications and fatal outcomes. Major surgical operations among general and urologic surgery (thyroidectomy, mastectomy, gastro-intestinal and hepato-biliary

surgery, nephrectomy, prostatectomy...), gynecologic surgery (hysterectomy, oophorectomy, myomectomy...) and orthopedic surgery (nailing, plating, fixations...) were included in this study [12, 27, 28].

**Recent prior surgery:** Postoperative anemia can be explained by acute blood loss and the inflammatory state induced by surgery itself, leading to altered erythropoiesis and iron metabolism which reduced availability of iron when the body attempts to compensate. So commonly it needs 1–2 month to be corrected satisfactorily. Hence, any major surgical operation performed within 2 months before the current surgery was counted as a recent prior surgery [29].

To determine sample size, single population proportion formula was used. A study done in South Africa has reported that the prevalence of preoperative anemia was 42.3% [2]. By assuming 95% of confidence interval with 5% margin of error, the sample size for the study was calculated by using a single population proportion formula as:

$$n = \left( Z_{\frac{\alpha}{2}} \right)^2 \times p(1-p) / \epsilon^2$$

We have  $p = 0.423$ ,  $\epsilon = 0.05$ ,  $Z_{\alpha/2}$  at 95% CI = 1.96

$$n = (1.96)^2 \times (0.423 \times 0.577) / (0.05)^2$$

$$n = 383.028 \approx 384.$$

The total number of adult major elective surgery performed in the hospital annually was below 10,000 and we found out there were only average of 100 major elective surgical procedures done per a month by reviewing the operation registry. Additionally, COVID-19 pandemic has compromise the flow of elective surgical patients to the hospital. So we decided to apply reduction formula to obtain an achievable sample size.

$$nf = \frac{n}{1 + n/N}$$

$$nf = \frac{384}{1 + 384/300} \approx 168 \text{ with addition of 10\% non-response rate, } nf = 185,$$

All eligible consecutive adult patients scheduled for major elective surgery were included in the study till the calculated sample size reached.

After ethical approval (**Reference number: 1936/03/2020**) was obtained from Ethical Review Committee of School of Medicine and informed consent from each participant, data were collected by using a pre-tested structured questionnaire (the pre-test was conducted among 10 (5%) patients whose data were not included in the main results). The questionnaire was primarily prepared in English language and translated to Amharic language. Training for data collectors and supervisors was provided by the principal investigator. After completion of data collection, the variables were coded and cleaned. The data was entered into the Epi-data software (version 7) for cleaning errors and was analyzed by SPSS version 20 (IBM Corporate). The normality of the data was tested by using Shapiro-Wilk normality test. Descriptive statistical analyses were performed and presented with frequency, percentage, mean, standard deviation, median and inter-quartile range (IQR). The relationships of nominal data with preoperative anemia were analyzed by using cross-tabulations. Hosmer and Lemeshow test was used to assess the goodness of fit. The associations between the independent variables and dependent variable were determined at 95% confidence interval with chi-squared test, bivariate and multivariate binary logistic regression and presented in crude and adjusted odds ratio. The cut-points of statistical significance were P-value < 0.2 for bivariate and < 0.05 for multivariate regression.

## 3. Results

A total of 185 patients were included in the study with 100% response rate. The majority of participants 108 (58.4%) were females and 77 (41.6%) were males. The median (IQR) age of the study population was 39 (28–52) years. The ages of the majority 128 (69.2%) were between 15 – 49 years and the BMI of 125 (67.6%) patients was normal. As a developing world, most of the patients (58.9%) came from rural area

**Table 1.** The socio-demographic characteristics of adult patients underwent major elective surgery at UoGCSH, Northwest Ethiopia, 2020. (n = 185).

Variables	Frequency n (%)	Anemic (68) n (%)	Non-anemic (117) n (%)
<b>Sex</b>			
Male	77 (41.6)	30 (39)	47 (61)
Female	108 (58.4)	38 (35.2)	70 (64.8)
<b>Age</b>			
15–49 years	128 (69.2)	46 (35.9)	82 (64.1)
≥50 years	57 (30.8)	22 (38.6)	35 (61.4)
<b>Residence</b>			
Urban	76 (41.1)	26 (34.2)	50 (65.8)
Rural	109 (58.9)	42 (38.5)	67 (61.5)
<b>Educational status</b>			
Illiterate	75 (40.5)	31 (41.3)	44 (58.7)
Primary school	45 (24.3)	18 (40.0)	27 (60.0)
Secondary school	31 (16.8)	13 (41.9)	18 (58.1)
College and above	34 (18.4)	6 (17.6)	28 (82.4)

(Table 1). Hypertension was the most common comorbidity which was found among 21 (11.4%) patients. Twenty (10.8%) patients had HIV/AIDS. Most of the patients were classified as ASA I physical status.

**Table 2.** Preoperative clinical characteristics of the patient and their association with preoperative anemia among elective surgical patients in UoGCSH, Northwest Ethiopia, 2020. (N = 185).

Variables	Frequency (%)	Anemic (68) n (%)	Non-anemic (117) n (%)
<b>BMI (Kg/m<sup>2</sup>)</b>			
≤18.5	38 (20.5)	15 (39.5)	23 (60.5)
18–24.9	125 (67.6)	47 (37.6)	78 (62.4)
≥25	22 (11.9)	6 (27.3)	16 (72.7)
<b>Peptic ulcer disease</b>			
Yes	3 (1.6)	2 (66.7)	1 (33.3)
No	182 (98.4)	66 (36.3)	116 (63.7)
<b>Hypertension</b>			
Yes	21 (11.4)	9 (42.9)	12 (57.1)
No	164 (88.6)	59 (36.0)	105 (64.0)
<b>HIV/AIDS</b>			
Yes	20 (10.8)	15 (75.0)	5 (25.0)
No	165 (89.2)	53 (32.1)	112 (67.9)
<b>History of Malaria</b>			
Yes	8 (4.3)	4 (50.0)	4 (50.0)
No	177 (95.7)	64 (36.2)	113 (63.8)
<b>Diabetes mellitus</b>			
Yes	3 (1.6)	2 (66.7)	1 (33.3)
No	182 (98.4)	66 (36.3)	116 (63.7)
<b>Malignancy</b>			
Yes	14 (7.6)	10 (71.4)	4 (28.6)
No	171 (92.4)	58 (33.9)	113 (66.1)
<b>Asthma</b>			
Yes	2 (1.1)	0 (0)	2 (100.0)
No	183 (98.9)	68 (37.2)	115 (62.8)
<b>Other comorbidities</b>			
Yes	9 (4.9)	2 (22.2)	7 (77.8)
No	176 (95.1)	66 (37.5)	110 (62.5)
<b>Chronic NSAIDs</b>			
Yes	5 (2.7)	5 (100)	0 (0)
No	180 (97.3)	63 (35)	117 (65)
<b>Smoking</b>			
Yes	3 (1.6)	1 (33.3)	2 (66.7)
No	182 (98.4)	67 (36.8)	115 (63.2)
<b>Recent prior surgery</b>			
Yes	61 (33.0)	33 (54.1)	28 (45.9)
No	124 (67.0)	35 (28.2)	89 (71.8)
<b>ASA Status</b>			
ASA I	103 (55.7)	26 (25.2)	77 (74.8)
ASA II and III	82 (44.3)	42 (51.2)	40 (48.8)

Fourteen (7.6%) patients had cancer and 61 (33%) had undergone recent prior surgical operations (Table 2).

About 68 (36.8%, CI: 29.2–42.7%) patients had preoperative anemia. The means ± standard deviations of hemoglobin (g/dl) and hematocrit (%) levels were  $12.7 \pm 3.2$  and  $36.8 \pm 9.3$  respectively. The prevalence of preoperative anemia among male patients was 39% and female patients was 35.2%. Among anemic patient, 64.7% presented with mild anemia (Figure 1). The highest prevalence of preoperative anemia was noticed among patients with HIV/AIDS. Around 75% of patients with HIV/AIDS were found anemic during the preoperative period while 71.4% of patients with malignancy were also found anemic (Table 2).

After checking the appropriateness of the model for analysis using Hosmer-Lemeshow goodness of fit, we performed inferential statistical analysis. In the bivariate binary logistic regression analysis, ASA status, HIV/AIDS, malignancy, class of surgery and recent prior surgery were found significant ( $P < 0.2$ ) and fitted for the final analysis model. In the final multivariate binary logistic regression analysis, we found ASA status, malignancy, class of surgery and recent prior surgery significantly associated with preoperative anemia ( $p < 0.05$ ).

Our study indicated that the likelihood of having preoperative anemia was 9.4 times higher among patients with malignancy than those who has no malignancy (AOR: 9.4, CI: 2.0–43.4). Those patients who were classified in ASA II and III physical status were 3.8 times more likely to have preoperative anemia than those ASA I physical status (AOR: 3.8, CI: 1.6–9.2).

Patients who were scheduled for orthopedic surgical procedures were anemic than those scheduled for general and urologic surgery (AOR: 11.2, CI: 4.0–31.6). Similarly, compared to patients scheduled for general and urologic surgery, women came for gynecologic surgical operations were 5.2 times more likely to be anemic (AOR: 5.2, CI: 1.9–14.4). Furthermore, patients who had recent prior surgery were found to be anemic (AOR: 3.3, CI: 1.3–8.5) (Table 3).

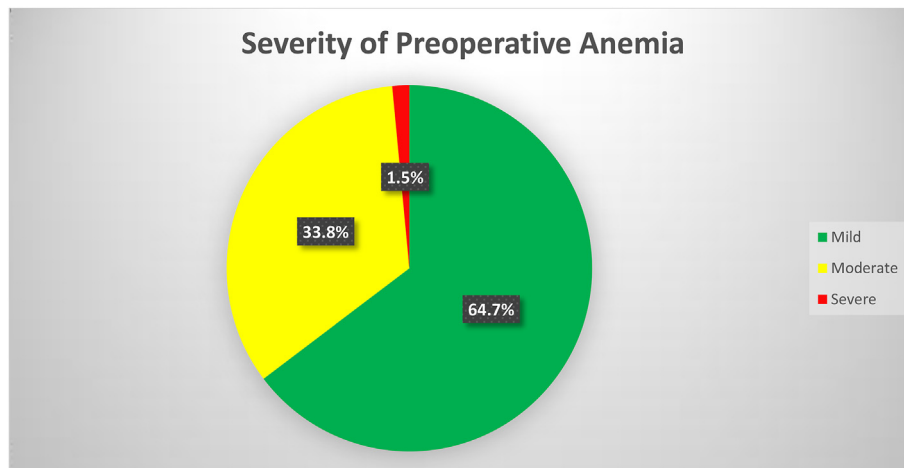
#### 4. Discussion

Preoperative anemia was found in 36.8% patients who were scheduled for major elective surgery at UoGCSH. Out of which, 64.7% presented with mild, 33.8% with moderate and 1.5% with severe anemia. Comparably, a study done in South Africa on adult elective surgical patients showed that the prevalence of preoperative anemia was 42.3%; of which 95.1% had mild to moderate anemia and 4.9% had severe anemia [2]. Another study done in Ghana on adult surgical patients showed that the prevalence of preoperative anemia was 54.3%; out of which, 43.1% presented with mild anemia, 46.6% with moderate anemia and 10.3% with severe anemia [26]. The possible reasons for the variations might be explained by the inclusion of patients came for both emergency and elective surgical operations in the study from Ghana.

Multiple review articles have concluded that the prevalence of preoperative anemia between 30% and 40%. It was estimated to occur in 35% surgical patients in a study done by Muñoz M. *et al* [16] and 40% in an article published by Munting K. *et al* [21]. Preoperative anemia has been reported to affect 54.4% of patients scheduled for cardiac surgery and 39% for non-cardiac surgery [30]. Supporting these findings, another review article has concluded that the prevalence of preoperative anemia among patients scheduled for major elective surgery was around 30–40% [22].

Irrespectively, lower results were reported in some studies. In a study done in Singapore, preoperative anemia was found among 27.8% surgical patients [25]. Furthermore, studies done in Australia have verified that 13.9% elective surgical patients and 20% orthopedic patients were anemic preoperatively [15, 31]. The discrepancies might be explained by socioeconomic differences, specificity of study population and use of multicenter design in the previous studies [32].

Preoperative anemia occurred in more than 9 folds higher among patients who had malignancy than those who had not. This finding was supported by other published evidences [33, 34, 35]. The proposed



**Figure 1.** Prevalence and severity of preoperative anemia among adult elective major surgical patients in University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia, 2020. (n = 68).

mechanism of preoperative anemia in patients with malignancy is red blood cells fragmentation due to direct contact with tumor emboli within blood vessels or formations of intraluminal fibrin thrombi [35]. In addition, patients classified under ASA II and III physical status had preoperative anemia nearly 4 times more likely than those classified under ASA I physical status. The phenomenon might be explained by the presence of more severe comorbidities and chronic diseases in patients with higher ASA classes [25, 36].

In the current study, we found that the classes of surgery were independently associated with preoperative anemia. Patients scheduled for orthopedic surgery were over 11 times anemic than those scheduled for general and urologic surgery. Supporting our findings, a review article has reported that preoperative anemia was more prevalent in patients that undergone fracture repair surgery [22]. The possible reason might be pre-existing traumatic blood loss and repeated prior surgery in orthopedic patients for debridement and revision surgery [37]. Most of orthopedic patients in our study had traumatic causes that could induce acute and chronic inflammatory responses; therefore, blunted erythropoiesis and diminished sensitivity due to decreased iron availability that result in anemia. Supporting our study, high prevalence of preoperative anemia was

reported among patients scheduled for major orthopedic surgery [22]. Despite our finding, much lower prevalence of preoperative anemia have been reported in patients scheduled for major orthopedic surgery [15]. Furthermore, gynecologic patients were at higher risk to present with preoperative anemia than those came for general and urologic surgery. Comparably with previous studies, gynecologic diseases are usually complicated with abnormal uterine bleeding [16].

Significant association was observed between recent prior surgery and preoperative anemia. Patients who had recent prior surgery were over 3 times more likely to be anemic on the preoperative period of the consecutive surgery. Comparable results were reported in other studies [25, 38], and can be justified by operative blood loss, blunted postoperative erythropoiesis and depressed bone marrow function after surgery [10, 16].

This study is the first of its type in the study area and in the country, Ethiopia. It has determined the prevalence and factors associated with preoperative anemia. It will be used as a cornerstone for future advanced studies in the study area and abroad. The possible limitations of the current study are, no determination of types of anemia according to causes and cytological analyses, and as a cross-sectional study design cause and effect relationships could not be demonstrated.

**Table 3.** Bivariate and multivariate binary logistic regression: Factors associated with preoperative anemia among adult elective surgical patients at UoGCSH, Northwest Ethiopia, 2020, (N = 185).

Variables	Anemia status		Odds ratio (95% CI)		P-values
	Yes n (%)	No n (%)	Crude	Adjusted	
<b>ASA status</b>					
ASA I	26 (25.2)	77 (74.8)	1	1	0.02
ASA II and III	42 (51.2)	40 (48.8)	3.1 (1.7–5.8)	3.8 (1.6–9.2)	
<b>HIV/AIDS</b>					
Yes	15 (75.0)	5 (25.0)	6.3 (2.2–18.4)	1.2 (0.2–7.1)	0.09
No	53 (32.1)	112 (67.9)	1	1	
<b>Malignancy</b>					
Yes	10 (71.4)	4 (28.6)	4.9 (1.5–16.2)	9.4 (2.0–43.4)	0.032
No	58 (33.9)	113 (66.1)	1	1	
<b>Class of surgery</b>					
General surgery and Urology	19 (18.6)	83 (81.4)	1	1	0.025
Gynecologic	20 (51.3)	19 (48.7)	4.6 (2.1–10.3)	5.2 (1.9–14.4)	
Orthopedics	29 (65.9)	15 (34.1)	8.5 (3.8–18.8)	11.2 (4.0–31.6)	
<b>Recent prior surgery</b>					
Yes	33 (54.1)	28 (45.9)	3.0 (1.6–5.7)	3.3 (1.3–8.5)	0.011
No	35 (28.2)	89 (71.8)	1	1	

Hosmer-Lemeshow test = 0.544.

AIDS: Acquired Immuno-deficiency Syndrome, ASA: American Society of Anesthesiologists, CI: Confidence Interval, HIV: Human Immuno-deficiency Virus.

## 5. Conclusions

The overall prevalence of preoperative anemia among adult patients scheduled for major elective surgery was high. Malignancy, ASA II and III physical status, orthopedic surgery, gynecologic surgery and recent prior surgery were found significantly associated with preoperative anemia. We recommend to clinicians to aim prevention and early detection of preoperative anemia. Patients with preoperative anemia should be optimized with safe and low-cost hematinic supplements to reduce the risks of anemia and related adverse outcomes. As a developing country, the prevalence of anemia is high in the general population. The government and policy makers should design affordable preventive and therapeutic strategies to minimize the burdens of anemia and its negative impacts.

## Ethics approval and consent to participate

Ethical clearance to conduct the research was obtained from Ethical Review Committee of School of Medicine, University of Gondar. Written informed consent was obtained from each study patients after brief explanation. Confidentiality was ensured by removing identifiers and locking the questionnaires. When patients were found to have anemia in the preoperative period, the data collectors had reported for the corresponding care givers (Anesthetist, Surgeon or Nurse) to provide appropriate management for anemia.

## Consent for publication

Not applicable; this article does not include any personal or clinical details of any participant.

## Declarations

### Author contribution statement

Amare Anley Beyable: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Yophtahe Woldegerima Berhe: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Yonas Addisu Nigatu, and Hailiu Yimer Tawuye: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

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### Data availability statement

Data will be made available on request.

### Declaration of interests statement

The authors declare no conflict of interest.

### Additional information

No additional information is available for this paper.

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