HARAMAYA UNIVERSITY

COLLEGE OF HEALTH AND MEDICAL SCIENCES

SCHOOL OF GRADUATE STUDIES

Magnitude and Associated Factors of Preoperative Anemia Among Adult Elective Surgical Patients at Public Hospitals of Harar, Eastern Ethiopia.

By: Abdulmejid Gudu (MD)

College: Health and Medical Sciences

School: Medicine

Program: Anesthesiology, Critical Care and Pain Medicine

Advisors:

Major advisor: Sirak Worku (MD, Assistant professor of ACCPM)

Co-advisor: Assefa Tola (Assistant professor of Epidemiology)

December 2025 G.C

Harar, Ethiopia

MAGNITUDE AND ASSOCIATED FACTORS OF PREOPERATIVE ANEMIA AMONG ADULT ELECTIVE SURGICAL PATIENTS AT PUBLIC HOSPITALS OF HARAR, EASTERN ETHIOPIA.

A THESIS SUBMITTED TO THE DEPARTMENT OF ANESTHESIOLOGY, CRITICAL CARE AND PAIN MEDICINE, SCHOOL OF GRADUATE STUDIES, HARAMAYA UNIVERSITY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE SPECIALITY CERTIFICATE IN ANESTHESIOLOGY, CRITICAL CARE AND PAIN MEDICINE

College: Health and Medical Science

School: Medicine

Department: Anesthesiology, Critical Care and Pain Medicine

Abdulmejid Gudu (MD)

December 2025 G.C

Harar, Ethiopia

APPROVAL SHEET
HARAMAYA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

I hereby certify that I have read and evaluated this thesis entitled "Magnitude and Associated Factors of Preoperative Anemia Among Adult Elective Surgical Patients at Public Hospitals of Harar, Eastern Ethiopia". Prepared under my guidance by Dr. Abdulmejid. I recommend that it can be submitted as fulfilling the thesis requirement.

1. Abdulmejid Gudu (MD) Signature_____ Date_____
2. Sirak Worku (MD, Assistant professor of ACCPM) _____ _____
   Major advisor Signature Date
3. Mr. Assefa Tola (Assistant professor of Epidemiology _____ _____
   Co-advisor Signature Date

As a member of the board of examiners of the MPH Open thesis defense examination, I certify that I have read and evaluated the thesis prepared by Dr. Abdulmejid and examined the candidate. I recommend that the thesis should be accepted as fulfilling the thesis requirement for the speciality certificate in anesthesiology, critical care and pain medicine.

_____	_____	_____
Chair Person	Signature	Date
_____	_____	_____
Internal Examiner	Signature	Date
_____	_____	_____
External Examiner	Signature	Date

Final approval and acceptance of the Thesis are contingent upon the submission of its final copy to the Council of Graduate Studies (CGS) through the candidate's department or school graduate committee (DGC or SGC).

STATEMENT OF THE AUTHOR

By my signature below, I declare and affirm that this thesis is my work. I have followed all ethical and technical principles of scholarship in the preparation, data collection, data analysis and compilation of this thesis. Any scholarly matter that is included in the thesis has been given recognized through citation.

This thesis is submitted in partial fulfillment of the requirements for a speciality certificate in anesthesiology, critical care and pain medicine at Haramaya University. The thesis is deposited in the Haramaya University Library and is made available to borrowers under the rules of the library. I solemnly declare that this thesis has not been submitted to any other institution anywhere for the award of any academic degree, diploma or certificate

Brief quotations from this thesis may be made without special permission provided that accurate and complete acknowledgement of the source is made. Requests for permission for extended quotations from or reproduction of this thesis in whole or in part may be granted by the head of the school or department when in his or her judgment the proposed use of the material is in the interest of scholarship. In all other instances, however, permission must be obtained from the author of the thesis.

Name: Abdulmejid Gudu (MD)

Signature_____

Date_____

School/Department: Medicine

BIOGRAPHICAL SKETCH

My name is Dr. Abdulmejid Gudu (MD). I was born in Addis Ababa, Ethiopia. I have completed my elementary and secondary education at Eshet primary, Addis Ketama secondary and preparatory schools from 1997–2009. In 2010, I joined Haramaya University College of health and medical science and graduated in 2017. After graduation, I was employed and have served at warder hospital for 9 months and Haramaya University, College of Health and Medical Sciences, since October 2018 to present.

ACKNOWLEDGEMENTS

First and formost, I am wordlessly grateful for almighty Allah for all his priceless support and giving me all the strength. Secondly, I would like to forward my deepest gratitude to Haramaya University for favoring me in all the conditions to prepare this research thesis.

Thirdly, I would like to express my deepest gratitude to my advisors Dr. Sirak Worku and Mr. Assefa Tola for guiding me in all the way of completing this paper, for their valuable and insightful suggestions, comments and concerns in the process of this thesis preparation.

Most importantly, I would want to thank all the participants who kindly gave their time and cooperation while the data was being collected. The administrators and medical professionals at the two institutions for their unwavering hospitality. I want to express my gratitude to all three data collectors because their dedication and persistence allowed me to finish the report on time.

Lastly my special thanks goes to my colleagues who provided me constructive suggestions, guidance, comments and even necessary materials to write up this study.

CONTENTS

LISTS OF TABLES

LISTS OF FIGURES

ACRONYMS AND ABBREVIATIONS

ACCPM: Anesthesiology, Critical Care and Pain Medicine

AOR: Adjusted Odds Ratio

ASA: American Society of Anesthesiology

BMI: Body Mass Index

CI: Confidence Interval

DM: Diabetes Mellitus

EDHS: Ethiopian Demographic and Health Statistics

ERAS: Enhanced Recovery After Surgery

Hb: Hemoglobin

HFCSH: Hiwot Fana Comprehensive Specialized Hospital

HIV: Human Immunodeficiency Virus

ICU: Intensive Care Unit

IHREC: Institutional Health Research Ethical Review Committee

MCV: Mean Corpuscular Volume

OR: Odds Ratio

PRS: Plastic and Reconstractive Surgeries

PUD: Peptic Ulcer Diseases

RBCs: Red Blood Cells

SSA: Sub-Saharan Africa

UI: Uncertainty Interval

WHO: World Health Organization

SUMMARY

Background: Preoperative anemia, affecting about 35% of surgical patients, is a major risk factor for increased morbidity and mortality. It elevates the need for blood transfusion, which prolongs hospital stay and raises risks of infection, intensive care unit admission, cardiac events, stroke, and renal complications. Despite the seriousness of the problem there is information gap regarding the magnitude of preoperative anemia and its associated factors in the study area.

OBJECTIVE: To assess magnitude and associated factors of preoperative anemia among adult elective surgical patients at public hospitals of harar, Eastern Ethiopia, from July 1 to August 31, 2025.

Methods: Institution-based cross-sectional study was conducted among 394 adult elective surgical patients selected using a systematic random sampling technique. Data were collected from patient charts using a structured checklist, entered into EpiData version 4.6, and analyzed with STATA version 17. Descriptive statistics summarized patient characteristics. Factors with a p-value ≤0.2 in the bivariable models were candidates for the multivariable model. Adjusted odds ratios alongside 95% confidence intervals were estimated to measure the strength of association between variables of interest and level of statistical significance was declared at p-value < 0.05.

Result: Among 394 participants, mean age was 44 ± 14.7 years, and 56.9% were female. The mean hemoglobin level was 12.69 ± 1.9 g/dl. The overall prevalence of preoperative anemia was 38.6% (95% CI: 33.9 - 43.5). Female patients were less likely to be anemic than males (AOR = 0.46, 95% CI: 0.28 - 0.76). A unit increase in body mass index reduced preoperative anemia odds by 13% (AOR = 0.87, 95% CI: 0.79 - 0.96). Compared to general surgery, orthopedic and plastic/reconstructive surgeries had higher odds (AOR = 2.62, 95% CI: 1.46 - 4.69). History of blood loss was also significant (AOR = 2.41, 95% CI: 1.12 - 5.18).

Conclusion: Preoperative anemia affected nearly two out of five adult elective surgical patients in Harar. Factors such as low body mass index , orthopedic or reconstructive surgery, and a history of blood loss and male gender were linked to preoperative anemia. Therefore, it is crucial to Strengthen preoperative evaluation, nutritional support, and bleeding control measures to reduce the burden of anemia and improve surgical outcomes.

Key words: *associated factors, Eastern Ethiopia, Harar, Preoperative anemia.*

1. INTRODUCTION

1.1. BACKGROUND

Anemia is defined as a reduced number of circulating red blood cells (RBCs), or reduced hemoglobin concentration (Tibi, P., et al. 2021). According to the World Health Organization (WHO), a hemoglobin (Hb) level less than 13 g/dL or hematocrit (Hct) level less than 39% in adult men and Hb less than 12 g/dL or Hct level less than 36% in adult women are the diagnostic cutoffs (WHO, 2011).

Anemia can be classified according to several parameters. One such classification is based on the underlying mechanisms, which include decreased red blood cell (RBC) production, increased RBC destruction, and blood loss (Chaparro, C.M. et al., 2019). Additionally, anemia can be morphologically classified based on RBC size, specifically by mean corpuscular volume (MCV). This classification categorizes anemia as microcytic (MCV < 80 fL), macrocytic (MCV > 100 fL), or normocytic (MCV between 80 and 100 fL). Furthermore, an important clinical classification is based on the severity of anemia, which is categorized as mild (< 9.0–10.9 g/dL), moderate (< 7.0–8.9 g/dL), and severe (< 7.0 g/dL) (WHO, 2017).

Hemoglobin (Hb) is essential for transporting oxygen to tissues, and a decrease in Hb levels results in anemia. The most common clinical symptoms of anemia include fatigue, shortness of breath, bounding pulses or palpitations, conjunctival and palmar pallor, restless legs, near-syncope, chest pain, and reduced exercise tolerance. In cases of more severe anemia, patients may also experience pica (Turner, J., et al., 2024).

The pathophysiology of anemia varies significantly depending on its primary cause. For example, in acute hemorrhagic anemia, the restoration of blood volume through the infusion of intracellular and extracellular fluids dilutes the remaining red blood cells (RBCs), leading to anemia. RBCs are produced in the bone marrow and subsequently released into circulation, with approximately 1% of RBCs removed from the circulation daily. An imbalance between the production and removal or destruction of RBCs can result in anemia. The primary mechanisms contributing to anemia include increased RBC destruction (due to blood loss and hemolysis) and deficient or defective erythropoiesis (Badireddy, M., et al., 2021, and Amin, S.K. et al., 2023).

In 2019, there were 1.8 billion (95% UI: 1.7–1.8) prevalent cases of anemia across the world, the age-standardized point prevalence of anemia (per 100,000 population) was highest in South Asia (41646.1), Western SubSaharan Africa (40977.0) and Central Sub-Saharan Africa (36861.4) and Western Europe (4880.1), Australasia (6765.7) and High-income North America (6920.0) had the lowest age-standardized rates (Safiri, S., et al., 2021).

Anemia is associated with adverse health outcomes, including increased morbidity and mortality. In 2019, anemia accounted for 50 million years of healthy life lost due to disability. The condition imposes substantial economic costs due to decreased productivity and increased healthcare expenditures (Safiri, S., et al., 2021 and Marcus, H., et al., 2021).

Prevention of preoperative anemia requires both short-term and long-term strategies. In practice, achieving safe levels of preoperative Hb level is very difficult, epecially in a developing country like Ethiopia, if possible at all. This is because factors associated with preoperative anemia are multiple and complex. Studies show the role of different factors in preoperative anemia. Age, gender, body mass index (BMI), ASA physical status, smoking, malignancy, HIV, DM, renal diseases, malaria, intestinal parasitosis, asthma, PUD, recent prior surgery, type of planned surgery, use of medications, etc., to be among the factors that play the major role in the development of preoperative anemia (Diress, G.M. et al., 2023, Biset, W.M., et al., 2024, and Burton, B.N, et al. 2018). Therefore, this study aimed to assess the prevalence and associated risk factors for preoperative anemia in adult elective surgical patients at public hospitals in Harar, Ethiopia.

1.2. Statement of the Problem

Anemia is commonly encountered in the preoperative setting when patients are being evaluated for surgery. Preoperative anemia is an emerging concern in patients scheduled for surgical procedures (Burton, B.N., et al., 2018). It is a prevalent finding in the preoperative setting and a significant public health concern on a global scale. It is the most common functional impairment in the world, affecting almost one-third of the population (Goodnough et al., 2011). It is thought to affect about 35% of surgical patients worldwide (Muñoz et al., 2015). Depending on the type of surgery and screening procedures, prevalence rates in high-income nations can range from 20% to 30% (Shander, et al., 2011). However, the burden is significantly higher, often over 40%, in low- and middle-income countries (LMICs) (Beaudoin, et al., 2022).

The biggest burden is found in Sub-Saharan Africa (SSA), where between 40% and 60% of surgical patients are estimated to have anemia (Chikumbanje et al., 2020). Anemia is still a major problem in Ethiopia, where population-based studies show prevalence rates of above 30%, especially in vulnerable populations (EDHS, 2016). According to research conducted in hospitals, preoperative anemia in surgical patients can range from 35% to 60% (Fentie, et al., 2020). The prevalence is thought to be much higher in the eastern region of Ethiopia, where late surgical presentation, dietary deficiencies, and socioeconomic constraints are more prevalent.

Preoperative anemia has been shown to be an independent risk factor for increased morbidity and mortality in surgical patients undergoing elective surgery (Karkouti, K., et.al., 2008). Preoperative anemia is a powerful indicator of the need for blood transfusion; however, transfusion itself is independently associated with increased length of stay, surgical complications, and increased morbidity and mortality (Musallam, K.M., et al. 2021, and Kotze, A., et.al., 2012). Preoperative anemia carries a risk of postoperative infections, intensive care unit admissions, increased length of hospital stay, readmission and reoperation rates. It's also an independent factor associated with perioperative stroke, heart failure, arrhythmias, renal impairment, and death in patients that have undergone both cardiac and non-cardiac surgery (Shander, A.,et al., 2014, Hong, F.S., et al., 2017, and Munoz, M., et.al., 2011).

Despite the seriousness of the problem there is an information gap regarding the prevalence of preoperative anemia and associated factors in the study area. This study intends to fill the knowledge gap on the prevalence of preoperative anemia and associated factors at Hiwot Fana Comprehensive Specialized Hospital and Jugal General Hospitals of Harar, Eastern Ethiopia.

1.3. SIGNIFICANCE OF THE STUDY

The result of this study will be used by Hiwot Fana Comprehensive Specialized Hospital and Jugal Regional Hospital to develop intervention plan in reducing the prevalence of preoperative anemia by identifying possibly preventable factors that are associated with preoperative anemia. It also can be used as an input by the Harari Regional Health Bureau and related stakeholders in planning for the prevention of preoperative anemia.

This study will benefit the surgeons and the anesthesia providers who are practicing in the study area by alarming them about the magnitude of the problem and making them pay due attention to

it so that they can improve their overall surgical outcomes. The findings of this research can help other researchers who are interested in writing about related topics in this study area.

Last but not least, this study will help me in fulfilling the partial requirement for my specialty training in anesthesiology, critical care and pain medicine.

1.4. OBJECTIVES

1.4.1. GENERAL OBJECTIVE

- To assess the magnitude and associated factors of preoperative anemia among adult elective surgical patients at Public Hospitals of Harar, Eastern Ethiopia, from July 1 to August 31, 2025.

1.4.2. SPECIFIC OBJECTIVES

- To assess the magnitude of preoperative anemia among adult elective surgical patients at Public Hospitals of Harar, Eastern Ethiopia, from July 1 to August 31, 2025.
- To assess the associated factors of preoperative anemia among adult elective surgical patients at at Public Hospitals of Harar, Eastern Ethiopia, from July 1 to August 31, 2025.

2. LITERATURE REVIEW

To optimize patient care and surgical outcomes, it is necessary to determine the magnitude of preoperative anemia and the factors contributing to its development. This section reviews the existing research on the magnitude of preoperative anemia and its contributory factors, focusing on sociodemographic characteristics and preoperative patient conditions.

2.1. Magnitude of Preoperative Anemia

Prevalence rates have varied according to patient demographics, surgery type, and geographic area. It is critical to understand the magnitude of preoperative anemia. This section attempts to summarize the findings from numerous research studies on the prevalence of preoperative anemia.

Globally, there is high burden of preoperative anemia. According to a worldwide data analysis from 211 hospitals found that 69,229 (30.44%) patients had preoperative anemia (Musallam, K.M., et al., 2011). In another large-scale study the mean preoperative anemia prevalence in 18 large observational studies, mostly from Europe, with approximately 650,000 surgical patients ranged from 10.5% to 47.9% (Muñoz, M., et al., 2015).

Preoperative anemia is also demonstrated in studies from Australia and Canada. In a study from Australia, the prevalence of preoperative anemia was found to be 208 (13.9%) (Hong, F.S., et al., 2017). In a multicenter cohort study from Canada, the overall prevalence of preoperative anemia was 26%, with values ranging from 22% to 30% at the participating hospitals (Karkouti, K., et al., 2015).

Preoperative anemia is also a problem in patients presenting for surgery in Asia. A study from China showed an incidence of preoperative anemia of 39.8% (754/1894) (Yan, T., et al., 2023). Another study from Singapore came up with an overall prevalence of 27.8% and mild anemia was 15.3%, moderate anemia was 12.0% and severe anemia was 0.5% (Sim, Y.E., et al., 2017).

Studies from Africa have shown significant magnitude of preoperative anemia. One such study from Ghana where the prevalence of preoperative anemia was 54.3%, mostly microcytic with or without hypochromia (57.2%) (Amponsah, G., et al., 2017). Similarly, in a study conducted in Congo and Madagascar which aimed to etablishe the effect of pre-operative anaemia on post-

operative complications in low-resource settings, 22.7, 13.9 and 1.4% met sex-related criteria for mild, moderate and severe anaemia, respectively (White, M.C., et al., 2017).

Findings from central and northern parts of Ethiopia shows a considerable prevalence of preoperative anemia among surgical patients. A study from Addis Ababa revealed the magnitude of preoperative anemia to be 27.1% (Biset, W.M., et al, 2024). In two separate studies conducted in northwest Ethiopia, one in University of Debre Tabor, preoperative anemia prevalence was 24.1% (Diress, G.M., et al., 2023) and in another study from University of Gondar, showed higher prevalence of preoperative anemia which is 36.8% (Beyable, A.A., et al., 2022).

2.2. Factors Associated with Preoperative Anemia

Preoperative anemia can be brought on by a multitude of factors. The factors that are associated with higher magnitude of preoperative anemia have been categorized into sociodemographic, clinical characteristics, nutritional and infection-related and chronic condition-related factors.

2.2.1. Socio-Demographic Factors

Several studies from different parts of the world showed association between preoperative anemia and multiple sociodemographic variables.

One of such sociodemographic variable is age. According to a recent large-scale study by Sim et al that examined over 97,000 surgical patients in Singapore and found that older age was independently associated with a higher likelihood of preoperative anemia. In their multivariable analysis, patients aged 70 years and above had significantly increased adjusted odds of both mild (AOR = 3.19, CI: 2.81–3.62) and moderate-to-severe anemia (AOR = 2.35, CI: 2.04–2.72) compared with those aged 18–29 years (Sim, et al., 2017).

A Singaporean study on preoperative anemia in older adults undergoing major abdominal surgery, the odds of preoperative anemia were 1.45 times greater for older patients than for younger ones (AOR = 1.45, CI: 1.21–1.73) (Yong, P.S.A., et al., 2024). In a retrospective study conducted in Spain on elective cardiac surgery patients, patient age was independently associated with preoperative anemia with (AOR = 1.037, CI: 1.017–1.056) (Muñoz, M., et al., 2010).

In a Northwest Ethiopian study on preoperative anemia, older patients had a somewhat greater percentage of preoperative anemia 38.6% than their younger counterparts 35.9%. However, we

are unsure if this discovery was statistically significant because age was left out of the multivariable analysis (Beyable, A.A., et al., 2022).

Another important sociodemographic factor is gender. In a study conducted in St.Paul's Millinium Medical College showed significant association between preoperative anemia and being female (AOR = 3.44, CI: 1.53, 7.73) as compared to their male counterparts (Biset, W.M., et al., 2024).

2.2.2. Preoperative Clinical Characteristics

Multiple clinical conditions are associated with preoperative anemia. For instance, in a retrospective study from Spain, the Variables independently associated with preoperative anemia were use of diuretics (AOR = 1.504, CI: 1.048–2.159) and use of PPI/H2 antagonists (AOR = 1.531 , CI: 1.066–2.201) (Muñoz, M., et al., 2010).

A study in China, emphasized that blood loss, whether due to prior illness or intraoperative factors, significantly contributes to reduced red cell mass and preoperative anemia, underscoring the importance of blood-loss minimization in patient blood management (Yan, et al., 2023). Similarly, a study conducted at St.Paul's Millinium Medical College, found that patients with infection or trauma-related surgical conditions, where ongoing or prior bleeding is common, were several times more likely to present with preoperative anemia (AOR = 3.58, CI: 1.35, 9.49) (Biset, W.M., et al., 2024).

A multicenter prospective observational cohort study from northwest Ethiopia showed that previous history of surgery (AOR = 1.9, CI: 1.43–2.4), was a factor with significant association with preoperative anemia (Diress, G., M., et al., 2023).

A cross-sectional study from University of Gondar identified that ASA physical status II and III (AOR = 3.8, CI: 1.6–9.2), recent prior surgery (AOR = 3.3, CI: 1.3–8.5), 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 (Beyable, A.A., et al., 2022).

2.2.3. Nutritional and Infection-related Factors

A multicenter prospective observational cohort study from northwest Ethiopia showed that having malaria infection (AOR = 3.2, 95% CI: 1.13–8.91), was a factor that showed significant association with preoperative anemia (Diress, G.M., et al., 2023).

In another study conducted at St.Paul's Millinium Medical College, being overweight (AOR = 0.26; 95% CI: 0.10, 0.88), and having infection as indications for surgery (AOR = 4.59; 95%CI: 1.62, 12.96) were significantly associated with preoperative anemia (Biset, W.M., et al., 2024).

2.2.4. Chronic Condition-related Factors

Multiple clinical conditions are associated with preoperative anemia. For instance in a retrospective study from Spain, the Variables independently associated with preoperative anemia included the presence of CKD (AOR = 3.161, CI: 1.258–7.946) (Muñoz, M., et al., 2010).

A multicenter prospective observational cohort study from northwest Ethiopia showed that patients with cancer had 3.4 times the odds of having preoperative anemia (AOR =3.4, CI: 3.7–8.84) and patients having antiretroviral therapy also had 5.2 times odds of having preoperative anemia (AOR = 5.2, CI: 1.8-11.04) as compared to other patients who did not have these chronic conditions. (Diress, G.M. et al., 2023).

A cross-sectional study from University of Gondar identified that history of malignancy (AOR = 9.4, CI: 2.0–43.4), as a significantly associated factor with preoperative anemia (Beyable, A.A., et al., 2022).

2.3. Conceptual Framework

The conceptual framework illustrates the relationship between preoperative anemia and its independent variables, as described in the literature review above. It was developed by the investigator after reviewing relevant studies extensively.

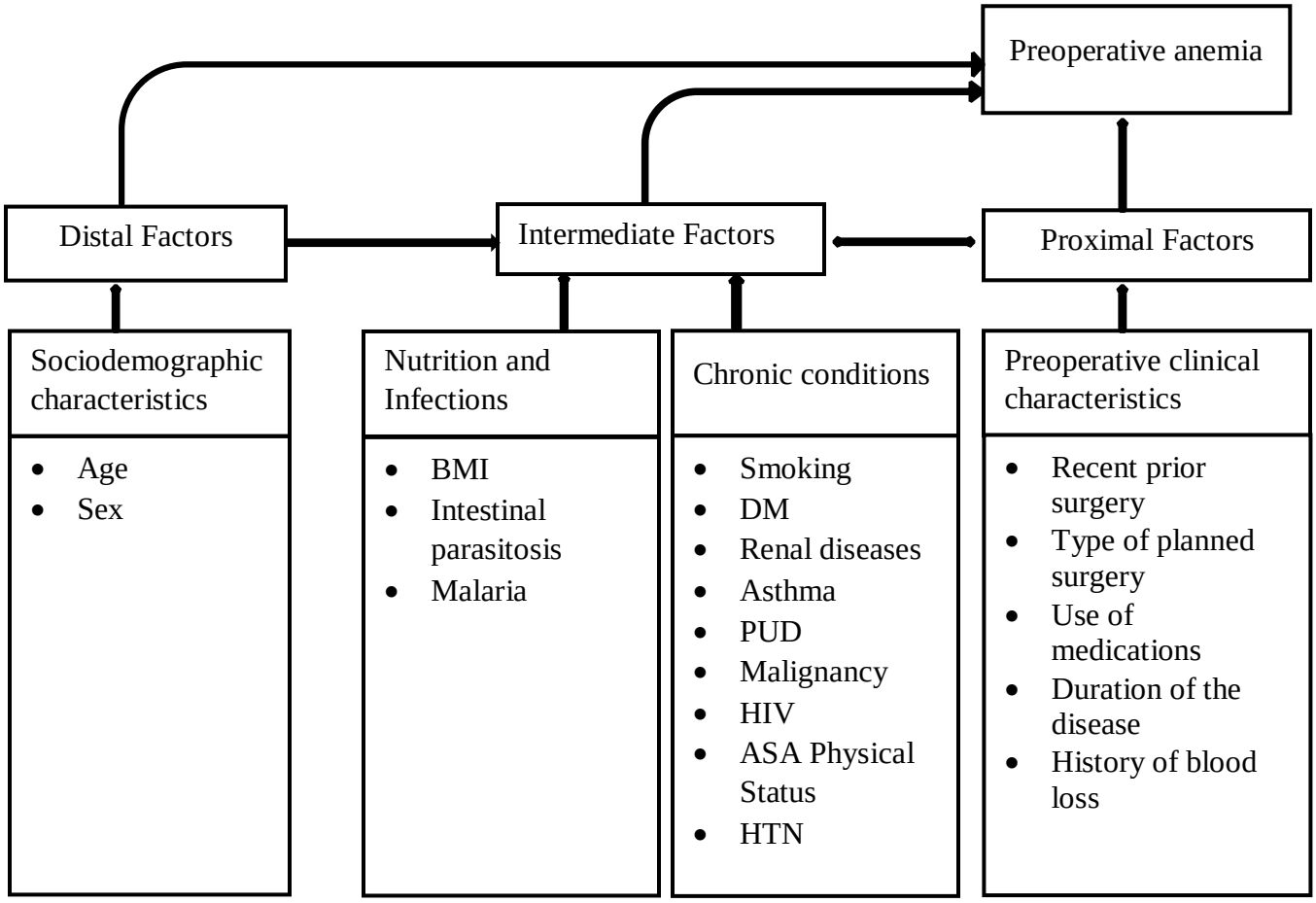

Figure 1. Conceptual framework showing associated factors of preoperative anemia

3. METHODS

3.1. Study Area and Period

Harar is located in Harari region, about 526 km away from Addis Ababa the capital city of Ethiopia. There are seven hospitals in the city; these are a teaching, a regional, a police, a defense force and two private hospitals. In addition, there are eight health centers, 31 private clinics, 26 health posts and one regional laboratory.

HFCSH is serving as a referral hospital for the entire eastern part of the country including Eastern Oromia, Dire Dawa city administration, Harari, and Somali regional states. Currently the hospital serves about 5.2 million people. It serves as a teaching center of Eastern Ethiopia. On the other hand, Jugal general hospital is the regional hospital of Harari regional state. It serves mainly to the people of Harari region.

The two hospitals are serving as a referral hospital for most of eastern part of the country. The hospitals provide various surgical services namely general surgery, pediatric surgery, neurosurgery, urologic surgery, ENT, maxillofacial, gynecological, orthopedic, plastic and selected laparoscopic surgeries.

Perioperative patient evaluation and optimization is one of the many clinical services provided by the department of ACCPM. The data collection period was from July 1 to August 31, 2025.

3.2. Study Design

Institution-based cross-sectional study design was used.

3.3. Population

3.3.1. Source Population

All elective surgical patients who were scheduled to undergo surgery at HFCSH and Jugal General hospitals.

3.3.2. Study Population

Adult elective surgical patients who were scheduled to undergo surgery during the study period.

3.4. ELIGIBILITY CRITERIA

3.4.1. Inclusion Criteria

Adult elective surgical patients were included in the study if they are aged 18 years and above, scheduled for and undergo elective surgery during the data collection period, and had recent preoperative hemoglobin and/or hematocrit results documented in their medical records.

3.4.2. Exclusion Criteria

Adult elective surgical patients who were receiving treatment for anemia, those whose surgeries **were rescheduled**, and pregnant women were excluded from the study.

3.5. Sample Size Determination

The sample size for prevalence of preoperative anemia was calculated by using the formula for single population proportion, $\mathbf{n= (Z_{a/2})^2 P*(1-P)/ d^2}$, where n is the sample size required; d, margin of error of 5% (d = 0.05); Z, the degree of accuracy required at 95% confidence level = 1.96; and P = 36.8% of prevalence of preoperative anemia (Beyable, A.A., et.al., 2022). Replacing in the formula $n= (1.96)^2(0.368)*(1-0.368)/(0.05)^2 = 358$.

The sample size for associated factors of preoperative anemia was calculated using OpenEpi two sided confidence level of 95%, power of 80%, and one to one ratio as it is depicted in the table below.

Table 1. Sample size calculation for associated factors of preoperative anemia among adult elective surgical patients at Public Hospitals of Harar, Eastern Ethiopia, from July 1 to August 31, 2025.

Associated factors	Assumptions	Sample size	Reference
Being female	AOR = 3.44 Percent of control exposed = 45	104	(Biset, et al., 2024)
ASA II and III	AOR = 3.8 Percent of control exposed = 34	92	(Beyable, et al., 2022)
Recent prior surgery	AOR = 3.3 Percent of control exposed = 24	100	(Beyable, et al., 2022)
Injury/trauma as indications for surgery	AOR = 3.58 Percent of control exposed = 14	114	(Biset, et al., 2024)

The required sample size for the second objective is 114. However, the sample size calculated for the first objective (358) is larger than that of the second. After adding a 10% for possible non-response, the final sample size for this study becomes 394.

3.6. Sampling Technique/Procedures

A systematic random sampling technique was employed to select 394 surgical cases from an estimated 640 elective surgeries scheduled between July 1 and August 31, 2025, across two public hospitals (HFCSH: 440 cases; Jugal: 200 cases). Proportional allocation based on the average daily surgical load (HFCSH: 11 cases/day; Jugal: 5 cases/day) was used to draw 271 samples from HFCSH and 123 from Jugal Hospital. The sampling interval (K) is calculated by dividing the total estimated surgeries by the required sample size (640/394), yielding an interval of approximately 2. The first case was selected randomly using lottery method from the first two surgeries, and every second case thereafter was included until the target is reached.

3.7. Data Collection Method

3.7.1. Data Collection Instruments

A structured data abstraction checklist was used as the data collection instrument which is developed after several similar literatures were reviewed thoroughly by the investigator **(**Diress, G.M. et.al., 2023, Biset, W.M., et.al., 2024, Burton, B.N, et al., 2018**)**. The checklist has 33 listed items arranged in four parts. Including Sociodemographic characteristics , Preoperative clinical characteristics, Nutritional and infection related factors and Chronic conditions related factors.

3.7.2. Data Collectors

Three BSc nurses who are working in surgical wards of the two hospitals were used as a data collectors.

3.7.3. Data Collection Procedure

The eligible individuals' medical chart was reviewed using a prepared data abstraction checklist.

3.8. Study Variables

3.8.1. Dependent Variables

- Preoperative anemia

3.8.2. Independent Variables

Sociodemographic charactoristics

- Age
- Sex

Preoperative clinical characteristics

- Recent prior surgery
- Type of planned surgery
- Use of medications
- Duration of the disease
- History of blood loss

Nutritional and infection related factors

- BMI
- Intestinal parasitosis
- Malaria

Chronic condition related factors

- Smoking
- DM
- Renal diseases
- Asthma
- PUD
- Malignancy
- HIV
- ASA Physical Status

3.9. Operational Definition

- **Preoperative anemia:** Percentage of patients with hemoglobin level less than 12 g/dL (hematocrit <36%) for non-pregnant women and less than 13 g/dL (hematocrit <39%) for men, based on preoperative laboratory results will be considered having preoperative anemia. (Beattie, W.S., et.al., 2009, Hong, F.S., 2017, Gandhi, S.J., et.al., 2017).

3.10. Data Quality Control

Necessary training was given for data collectors on the contents of the data collection tool, data collection procedures and ethical considerations during data collection by the principal investigator (PI). A pretest was conducted on randomly selected 20 (5% of the calculated sample size) adult elective surgical patients at Haramaya General hospital, a week before the actual data collection. Then, adjustments was made on the tool for final data collection. Close supervision was carried out on daily basis by the supervisor and the PI during the data collection time. Data from each data abstraction form was checked for completeness, clarity, consistency, and accuracy by the PI. Any missed or incorrectly filled form was sent back to the respective data collector for correction. Data cross check and data cleanup was done before analysis.

3.11. Methods of Analysis

The data was coded and entered into EpiData software version 4.6, which was then exported to STATA software version 17 for additional data cleaning and analysis. The study participants were categorized as yes-preoperative anemia, no_preoperative anemia based on their serum Hgb level. Each variable was checked for missing values and normality test was performed for continuous ones. Descriptive statistics such as mean, frequency, percentage and other measures were used to describe the independent variables. Multicollinearity was checked using the variance inflation factor (VIF). The mean VIF was 1.68 and all the individual VIF were < 5 showing no multicollinearity between the independent variables. A bivariable logistic regression analysis was done to select the variables to be entered into the final logistic multivariable analysis. Explanatory variables with p value less than 0.20 in bivariable logistic regression analysis were entered into the multivariable logistic regression analysis model using forward stepwise regression analysis approach and association between the independent variables and preoperative anemia was assessed using odds ratio at a 95% confidence interval. Every variable with P-values less than 0.05

in the multivariate logistic model was considered as statistically significant. The model's fitness was evaluated based on Hosmer and Lemeshow's goodness-of-fit statistics. Since the p value was 0.0896 and it is greater than 0.05 there is no evidence that the model is a poor fit.

3.12. Ethical Considerations

Ethical clearance was obtained from the Institutional Health Research Ethics Review Committee (IHREC) of Haramaya University, College of Health and Medical Science via an approval letter written on June 26, 2025 with reference number IHRERC/141/2025. After explaining the aim and the benefit of the study informed, voluntary written and signed consent was obtained from the medical directors of HFCSH and Jugal Regional Hospital. All the information retrieved was kept in a way that it could not interfere in personal confidentiality. Confidentiality of the information was maintained by omitting participants' names and personal identification.

3.13. Plan for Dissemination of the Study Result

The findings of the study will be submitted to the School of Medicine, School of Graduate Studies of College of Health and Medical Sciences Haramaya University in partial fulfillment for the specialty in Anesthesiology, Critical Care and Pain Medicine. The copy of the research will be given to the two hospitals as well. Upon approval, this study will be made available to the Haramaya University College of Health and Medical Sciences school of graduate studies' library. There is also a plan for publication in a peer-reviewed reputable journal to keep the information as widely available as possible.

4. RESULTS

4.1. Socio Demographic Characteristics

A total of 394 adult elective surgical patients were included in the study. The mean age of participants was 44 ± 14.7 years SD. More than half of the participants, 224 (56.85%) were female (Table 2).

Table 2. Socio demographic characteristics of adult elective surgical patients at Public Hospitals of Harar, Eastern Ethiopia, from July 1 to August 31, 2025 (N=394).

Variables	Categories	Frequency (%)
Sex	Female	224 (56.85)
	Male	170 (43.15)
Age	18-24 years	32 (8.12)
	25-44 years	156 (39.59)
	45-64 years	177 (44.92)
	65+ years	29 (7.36)

4.2. Preoperative Clinical Characteristics

More than half of the participants were scheduled for general surgery 202 (51.27%) and nearly a quarter of them, 97 (24.62%), for orthopedic surgery. Eighty-six (21.83%) of the study participants had recent surgery. Slightly higher than one-third (36.55%) of the participants were on medication for various reasons. The majority, 226 (57.36%), of the participants had the surgical condition for less than 3 months. About one-fifth (21.83%) of the study participants had history of recent blood loss (Table 3).

Table 3. Preoperative clinical characteristics of adult elective surgical patients at Public Hospitals of Harar, Eastern Ethiopia, from July 1 to August 31, 2025 (N=394).

Variables	Categories	Frequency (%)
Type of planned surgery	General surgery	202 (51.27)
	Orthopedic	97 (24.62)
	Neurosurgery	4 (1.02)
	ENT	1 (0.25)
	Maxillofacial	3 (0.76)
	Plastic and reconstructive	40 (10.15)
	Gynecology	47 (11.93)
Recent prior surgery	Yes	86 (21.83)
	No	308 (78.17)
Current medication use	Yes	144 (36.55)
	No	250 (63.45)
History of recent blood loss	Yes	86 (21.83)
	No	308 (78.17)
Duration of the disease	≤3 months (acute)	226 (57.36)
	>3–6 months (subacute)	131 (33.25)
	>6 months (chronic)	25 (6.35)

4.3. Nutritional, Infection, and Chronic Condition-Related Factors

The mean BMI of the participants was 23.97±2.88. Majority (66.50%) of the participants were well nourished (BMI = 18.5 – 24.9) according to the WHO nutritional status classification based on body mass index. None of the study participants were diagnosed as having intestinal parasite or malaria infection (**Error! Reference source not found.**).

Most of the participants had ASA physical status of low risk, class I 193 (48.98%) and class II 126 (31.98%) (Figure 2). On the other hand, a few of the participants had some sort of comorbid conditions like DM, HIV renal diseases, asthma, and malignancy (Table 4).

Table 4. Chronic condition related factors of adult elective surgical patients at Public Hospitals of Harar, Eastern Ethiopia, from July 1 to August 31, 2025 (N=394).

Variables	Categories	Frequency (%)
BMI	(<16.0) Severe underweight	1 (0.25)
	(17.0 – 18.4) Mild underweight	4 (1.02)
	(18.5 – 24.9) Normal weight	262 (66.50)
	(25.0 – 29.9) Overweight	111 (28.17)
	(35.0 – 39.9) Obese	13 (3.30)
	(≥ 40.0) Morbidly Obese	3 (0.76)
Smoking	Yes	16 (4.06)
	No	378 (95.94)
DM	Yes	30 (7.61)
	No	364 (92.39)
Hypertension	Yes	41 (10.41)
	No	353 (89.59)
Renal diseases	Yes	3 (0.76)
	No	391 (99.24)
Asthma	Yes	2 (0.51)
	No	392 (99.49)
Malignancy	Yes	76 (19.29)
	No	318 (80.71)
HIV	Yes	9 (2.28)
	No	385 (97.72)

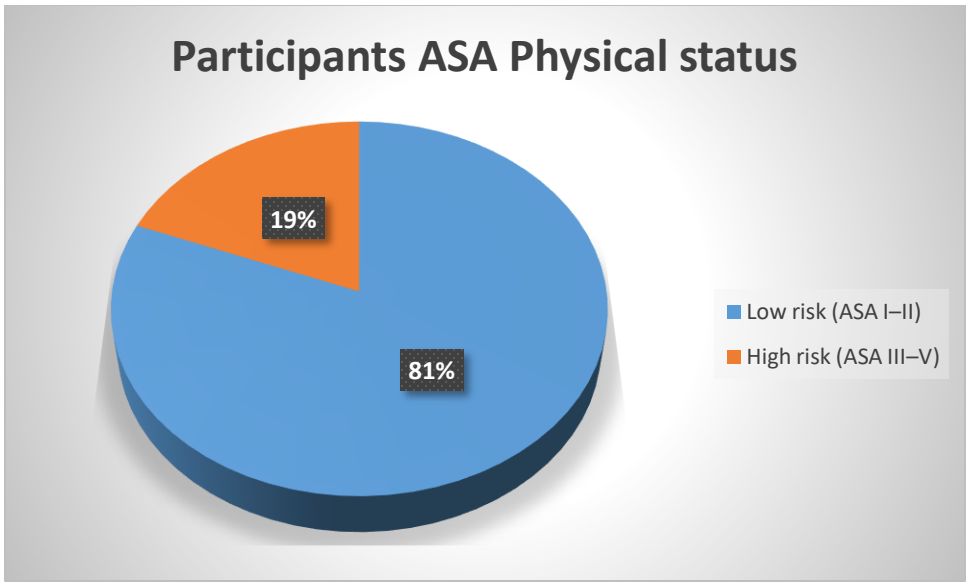

Figure 2. ASA physical status of adult elective surgical patients at Public Hospitals of Harar, Eastern Ethiopia, from July 1 to August 31, 2025 (N=394).

4.4. Magnitude of Preoperative Anemia

The mean hemoglobin was 12.69 ± 1.9g/dl. The mean Hb for males was 12.82g/d while the mean Hb for females was 12.58g/dl. The overall magnitude of preoperative anemia was 152 (38.58%) (95%CI: 33.88 – 43.50). The highest prevalence of preoperative anemia, 63 (41.45%), was seen among middle-aged patients (45–64 years). Among the participants, eighty-three (54.61%) of the males and sixty-nine (45.39%) of the females, had preoperative anemia. Forty (26.32%) of the anemic participants also showed an abnormal platelet count. Fifteen (9.87%) of the individuals with preoperative anemia had abnormally low or high white blood cell count.

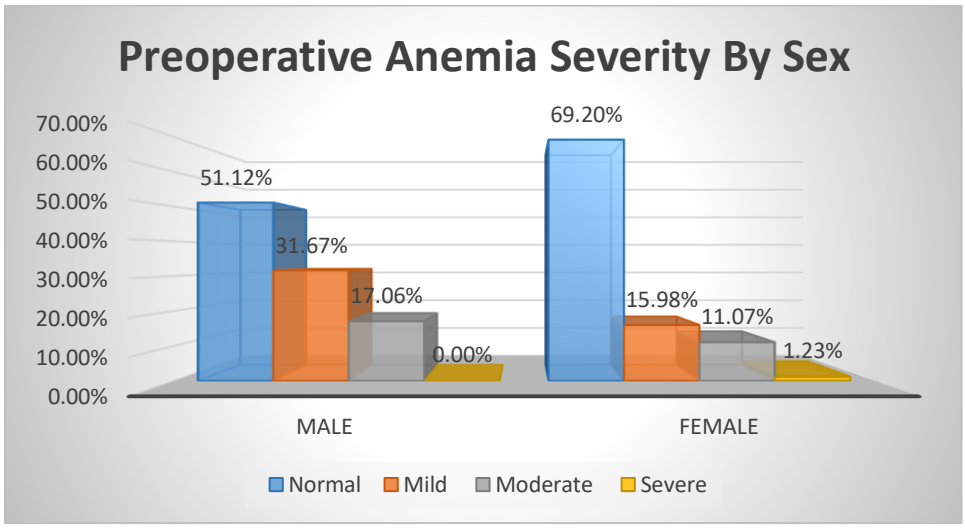

Figure 3. preoperative anemia severity among adult elective surgical patients at Public Hospitals of Harar, Eastern Ethiopia, from July 1 to August 31, 2025 (N=394).

Among the participants with preoperative anemia, 57 (37.50%) had recently undergone surgery, 73 (48.03%) had experienced recent blood loss, 64 (42.11%) were taking medication at the time of the study, 97 (63.82%) were presented for an acute condition, and 52 (34.21%) were scheduled by the general surgery side.

While the majority (69.08%) of individuals with anemia were well nourished, slightly less than one-third (28.95%) of them were overweight. Preoperative anemia was found in 30 (39.5%) of cancer patients, 20 (46.5%) of Khat chewers, 9 (56.2%) of smokers, 10 (33.3%) of diabetics, 2 (22.2%) of HIV-positive people, 5 (12.2%) of hypertensive participants and 2 (66.7%) of individuals with renal diseases.

4.5. Factors Associated with Preoperative Anemia

All independent variables with a p-value of less than 0.2 in the bivariable logistic regression were included in the multivariable model. These included sex, height, BMI, white blood cell count, platelet category, type of surgery, duration of illness, recent surgery, current medication use, recent blood loss, ASA physical status, hypertension, and smoking status. In the multivariable logistic regression analysis, only sex, BMI, type of surgery, and recent blood loss showed statistically significant associations with preoperative anemia.

After adjusting for other factors, female patients were less likely to have preoperative anemia compared with males (AOR = 0.46, 95% CI: 0.28–0.76). A unit increase in body mass index (BMI) was linked to a 13% reduction in the likelihood of anemia (AOR = 0.87, 95% CI: 0.79–0.96). Compared with general surgery, patients undergoing orthopedic and plastic/reconstructive procedures had significantly higher odds of preoperative anemia (AOR = 2.62, 95% CI: 1.46–4.69). Similarly, patients with a history of recent blood loss were more than twice as likely to be anemic (AOR = 2.41, 95% CI: 1.12–5.18).

Table 5. Factors Associated with preoperative anemia among adult elective surgical patients at Public Hospitals of Harar, Eastern Ethiopia, from July 1 to August 31, 2025 (N=394).

Factors	Categories	Preoperative anemia		COR (95%CI)	AOR (95%CI)	P value
		Yes (%)	No (%)			
Sex	Male	83 (48.82)	87 (51.18)	1	1	
	Female	69 (30.80)	155 (69.20)	0.47 (0.31- 0.71)	0.46 (0.28 – 0.76)	0.002*
Platelate count	Normal	112 (35.44)	204 (64.56)	1	1	
	abnormal	40 (51.28)	38 (48.72)	1.92 (1.16-3.16)	1.63(0.95-2.79)	0.078
Recent surgery	No	95 (30.84)	213 (69.16)	1	1	
	Yes	57 (66.28)	29 (33.72)	4.41 (2.65-7.33)	1.61 (0.71-3.63)	0.252
Recent blood loss	No	79 (30.66)	199 (69.34)	1	1	
	Yes	73 (62.93)	43 (37.07)	4.28 (2.70 - 6.76)	2.41 (1.12 – 5.18)	0.025*
Surgery type	General surgeries	52 (24.76)	158 (75.24)	1	1	
	Gynecologic surgeries	14 (29.79)	33 (70.21)	1.29 (0.64 - 2.59)	1.52 (0.69 – 3.33)	0.295
	Orthopedic and PRS	86 (62.77)	51 (37.23)	5.12 (3.21 - 8.17)	2.62 (1.46 – 4.69)	0.001*
BMI				0.87 (0.80 - 0.94)	0.87 (0.79 – 0.96)	0.005*

*Note * p value <0.05, *, COR= crude odds ratio, AOR= adjusted odds ratio, BMI=body mass index, PRS=plastic and reconstructive surgeries.*

5. DISCUSSION

This study was carried out to assess the magnitude and associated factors of preoperative anemia among adult elective surgical patients at public hospitals of Harar, Eastern Ethiopia. Preoperative anemia was observed among 152 (38.58%) (95% CI: 33.88 – 43.50) of the participants. Sex, BMI, surgery type, and recent blood loss were significantly associated with preoperative anemia.

In this study, the magnitude of preoperative anemia was 38.58%. This magnitude is comparable to several reports from similar surgical populations. For example, a study from China reported a prevalence of 39.8% (Yan, et al., 2023), and the University of Gondar study reported 36.8% (Beyable, et al., 2022). Both values fall close to our estimate and are within our 95% confidence interval, suggesting similarity in burden across these settings.

Our finding is lower than that reported in Ghana by Amponsah & Charwudzi, where preoperative anemia reached 54.3% (Amponsah, et al., 2017) a difference that may reflect higher rates of nutritional iron deficiency, parasitic disease, or limited preoperative optimization in that study population. Conversely, our prevalence is higher than estimates from several higher-income country cohorts and some other regional reports: Hong, et al., an Australian study found 13.9%, (Hong., et al., 2017), A Canadian study reported 26% (Karkouti, et al., 2015), a study from Singapore reported 27.8% (Sim., et al., 2017) and two Ethiopian studies from Addis Ababa = 27.1%; (Biset., et al., 2024) and from Debre Tabor = 24.1% (Diress., et al., 2017) reported lower prevalence.

These between-study differences are plausibly explained by variation in case-mix (our sample included a substantial proportion of general and orthopedic and PRS cases and 19% cancer patients), population nutritional status, burden of chronic disease, local prevalence of parasitic or infectious contributors to anemia, timing and methods of hemoglobin measurement, the anemia definition/cutoffs applied, and availability of preoperative optimization programs (screening, iron therapy, erythropoiesis-stimulating strategies). Notably, our 95% CI (33.88–43.50) overlaps with the Chinese and Gondar estimates, supporting that our observed prevalence is broadly consistent with other middle-income and regional hospital-based samples, while being distinctly higher than many high-income country estimates where systematic preoperative anemia management may be more established.

Overall, the high burden observed in this study underscores the need for routine preoperative hemoglobin screening and targeted optimization (nutritional assessment, iron studies and therapy, and attention to recent blood loss and oncologic patients) to reduce perioperative risk (Muñoz, M., et al., 2015).

After adjusting for other covariates, female patients were significantly less likely to have preoperative anemia compared with males (AOR = 0.46, 95% CI: 0.28–0.76)

This finding contrasts with many previous reports, where females generally had a higher prevalence of anemia. Studies from Gondar (Beyable., et al., 2022), Debre Tabor (Diress., et al., 2017), and China (Yan., et al., 2023) all found female sex to be a significant risk factor for preoperative anemia. These differences could be explained by variations in case mix and inclusion criteria; for example, a large proportion of female participants in our study underwent gynecologic and plastic/reconstructive surgeries, which are often elective and performed in relatively healthier patients with fewer pre-existing comorbidities. Additionally, cultural and socioeconomic factors may influence nutritional status and healthcare access differently across settings (Morgan, G. E., et al., 2020). The male predominance of anemia in our finding could also be due to a higher proportion of men undergoing major general and orthopedic surgeries associated with chronic disease or previous blood loss (Hong., et al., 2017).

A unit increase in BMI was associated with a 13% reduction in the odds of anemia (AOR = 0.87, 95% CI: 0.79–0.96).

This inverse relationship aligns with findings from (Hong., et al., 2017) and (Sim., et al., 2017), who observed lower anemia rates among well-nourished surgical patients. Similar patterns were reported in (Karkouti., et al., 2015), where malnutrition and low BMI were predictors of preoperative anemia. Low BMI typically reflects poor nutritional reserves and possible iron, folate, or vitamin B12 deficiency, which are major contributors to anemia (Munuz., et al., 2022).

The current findings are further supported by a study from St. Paul's Millennium Medical College, where being overweight was associated with substantially lower odds of preoperative anemia (AOR 0.26; 95 percent CI 0.10 to 0.88) as shown by (Biset, W.M., et al., 2024). This reinforces the notion that higher BMI categories may reflect better nutritional status, including adequate iron intake and a lower burden of chronic wasting illnesses, consistent with patterns noted by (Shander

et al. 2011). Nevertheless, extremely high BMI (obesity) can be associated with anemia of chronic inflammation that increases hepcidin levels, thereby reducing iron absorption and contributing to anaemia of chronic inflammation, though this was rare in our population (Cepeda-Lopez, A.C., et al., 2011).

Compared with general surgery, patients undergoing orthopedic and plastic/reconstructive surgeries had 2.6 times higher odds of preoperative anemia (AOR = 2.62, 95% CI: 1.46–4.69).

This finding is consistent with results from Ghana (Amponsah., et al., 2017) and Canada (Karkouti., et al., 2015), where orthopedic and major reconstructive procedures showed higher anemia rates. The likely explanations include the chronic nature of conditions leading to such surgeries (e.g., nonunion fractures, chronic ulcers, malignancy) and greater preoperative blood loss from prior interventions or trauma (Goodnough, L.T., et al., 2011).

However, findings across studies vary widely. For instance, a study in Ethiopia reported that orthopedic patients were over 11 times more likely to be anemic than those in general surgery (Beyable, et al., 2022), while large multicenter studies from Germany and China found no significant difference between surgical types. This variation likely reflects differences in patient profiles, trauma burden, referral patterns, and preoperative care, underscoring that the link between surgical specialty and preoperative anemia depends greatly on context.

A history of recent blood loss was strongly associated with preoperative anemia (AOR = 2.41, 95% CI: 1.12–5.18), which agrees with several studies. For example, (Yan., et al., 2023) in China and (Biset., et al., 2024) in Addis Ababa, both identified prior bleeding and peri-disease blood loss as major contributors to low preoperative hemoglobin levels. Acute or chronic bleeding whether from trauma, gastrointestinal lesions, or tumor-related hemorrhage directly depletes red cell mass and iron stores, leading to anemia (Kozek-Langenecker, S. A., et al., 2017).

In contrast, Dreijer A., et.al have shown that apparent links between prior hemorrhage and low hemoglobin weaken or disappear after adjusting for comorbid conditions, nutritional status, and disease-specific factors indicating recent blood loss might not be an independent driver of preoperative anemia once other factors are taken into account (Dreijer, A., et.al., 2019).

5.1. STRENGTHS AND LIMITATIONS OF THE STUDY

5.1.1. Strengths of the Study

This study is the first study that have assessed the magnitude and determinants of preoperative anemia among adult elective surgical patients in Eastern Ethiopia, providing valuable evidence for both surgical and anesthetic practice in the region.

5.1.2. Limitations of the Study

As an institution-based cross-sectional study, this research cannot establish causal relationships between preoperative anemia and its associated factors.

6. CONCLUSION AND RECOMMENDATION

6.1. Conclusion

The overall magnitude of preoperative anemia among adult elective surgical patients at public hospitals in Harar, Eastern Ethiopia, was 38.58%. After adjusting for confounding factors, male sex, low body mass index, orthopedic and reconstructive surgery types, and recent blood loss, were identified as significant predictors for preoperative anemia.

These findings underscore that preoperative anemia is a multifactorial problem influenced by nutritional status, surgical disease profile, and blood loss.

6.2. Recommendation

Health professionals should strengthen routine preoperative hemoglobin screening for all elective surgical patients. Particular attention should be given to individuals with low BMI, a history of recent blood loss, or those scheduled for orthopedic and reconstructive procedures, ensuring early evaluation and optimization. Integrating the early identification and management of anemia into preanesthetic protocols through nutritional counseling and treatment of underlying causes can significantly improve surgical readiness and outcomes.

Health institutions also play a crucial role by establishing hospital-based preoperative anemia screening and correction protocols. Ensuring the availability of essential laboratory tests such as complete blood count in preoperative clinics is vital.

For researchers, there is a pressing need for longitudinal and interventional studies to better understand the causal relationship between anemia and perioperative morbidity or mortality. Expanding research efforts to include multicenter studies across diverse regions of Ethiopia will strengthen external validity and contribute to the development of national, evidence-based strategies aimed at improving perioperative care and patient safety.

7. REFERENCE

1. Amin, S.K. and Antunes, C., 2023. Lower gastrointestinal bleeding. In StatPearls. StatPearls Publishing.
2. Amponsah, G. and Charwudzi, A., 2017. Preoperative anaemia and associated postoperative outcomes in noncardiac surgery patients in central region of Ghana. Anesthesiology research and practice, 2017(1), p.7410960.
3. Badireddy, M., Baradhi, K.M. and Wilhite Hughes, A., 2021. Chronic Anemia (Nursing)
4. Beattie, W.S., Karkouti, K., Wijeysundera, D.N. and Tait, G., 2009. Risk associated with preoperative anemia in noncardiac surgery: a single-center cohort study. Anesthesiology, 110(3), pp.574-581.
5. Beyable, A.A., Berhe, Y.W., Nigatu, Y.A. and Tawuye, H.Y., 2022. 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. Heliyon, 8(2).
6. Biset, W.M., Nasser, N., Tolu, L.B., Tsega, N.T. and Abraha, M., 2024. Magnitude and associated factors of preoperative anemia among adult elective surgical patients at Saint Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia, 2024. Frontiers in Medicine, 11, p.1466554.
7. Burton, B.N., Alison, M., Brovman, E.Y., Scott, M.J., Urman, R.D. and Gabriel, R.A., 2018. Optimizing preoperative anemia to improve patient outcomes. Anesthesiology Clinics, 36(4), pp.701-713.
8. Cepeda-Lopez A.C., Osendarp S.J., Melse-Boonstra A., Aeberli I., Gonzalez-Salazar F., Feskens E., et.al., 2011. Sharply higher rates of iron deficiency in obese Mexican women and children are predicted by obesity-related inflammation rather than by differences in dietary iron intake. The American journal of clinical nutrition, 93(5), pp.975-983.
9. Chaparro, C.M. and Suchdev, P.S., 2019. Anemia epidemiology, pathophysiology, and etiology in low-and middle-income countries. Annals of the new York Academy of Sciences, 1450(1), pp.15-31.
10. Diress, G.M. and Ayele, G., 2023. Prevalence and risk factors of preoperative anemia in patients undergoing elective orthopedic procedures in Northwest Ethiopia: a multicenter prospective observational cohort study. Patient Safety in Surgery, 17(1), p.29.
11. Dreijer A.R., Diepstraten J., Brouwer R., Croles F.N., Kragten E., Leebeek F.W.,et.al., 2019. Risk of bleeding in hospitalized patients on anticoagulant therapy: Prevalence and potential risk factors. European Journal of Internal Medicine, 62, pp.17-23.
12. Gandhi, S.J., Hagans, I., Nathan, K., Hunter, K. and Roy, S., 2017. Prevalence, comorbidity and investigation of anemia in the primary care office. Journal of clinical medicine research, 9(12), p.970.

13. Gómez-Ramirez, S., Jericó, C. and Muñoz, M., 2019. Perioperative anemia: prevalence, consequences and pathophysiology. Transfusion and Apheresis Science, 58(4), pp.369-374.
14. Goodnough, L.T., Maniatis, A., Earnshaw, P., Benoni, G., Beris, P., Bisbe, E., et al., 2011. Detection, evaluation, and management of preoperative anaemia in the elective orthopaedic surgical patient: NATA guidelines. British journal of anaesthesia, 106(1), pp.13-22.
15. Hong, F.S., Sieradzki, N., Pollock, C., Nasra, F., Mo, A., Willcox, A., et al., 2017. Prevalence and causes of preoperative anaemia in elective major surgery patients. Internal Medicine Journal, 47(12), pp.1400-1404.
16. Karkouti, K., Wijeysundera, D.N. and Beattie, W.S., 2008. Risk associated with preoperative anemia in cardiac surgery: a multicenter cohort study. Circulation, 117(4), pp.478-484.
17. Kotze, A., Carter, L.A. and Scally, A.J., 2012. Effect of a patient blood management programme on preoperative anaemia, transfusion rate, and outcome after primary hip or knee arthroplasty: a quality improvement cycle. British journal of anaesthesia, 108(6), pp.943-952.
18. Kozek-Langenecker S.A., Ahmed A.B., Afshari A., Albaladejo P., Aldecoa C., Barauskas G., et.al., 2017. Management of severe perioperative bleeding: guidelines from the European Society of Anaesthesiology: first update 2016. European Journal of Anaesthesiology| EJA, 34(6), pp.332-395.
19. Marcus, H., Schauer, C. and Zlotkin, S., 2021. Effect of Anemia on work productivity in both labor-and nonlabor-intensive occupations: a systematic narrative synthesis. Food De Hert, S.,
20. Muñoz, M., Gómez-Ramírez, S., Campos, A., Ruiz, J. and Liumbruno, G.M., 2015. Pre-operative anaemia: prevalence, consequences and approaches to management. Blood Transfusion, 13(3), p.370.
21. Muñoz, M., Ariza, D., Gómez-Ramírez, S.U.S.A.N.A., Hernández, P., García-Erce, J.A. et al., 2010. Preoperative anemia in elective cardiac surgery: prevalence, risk factors, and influence on postoperative outcome. Transfusion Alternatives in Transfusion Medicine, 11(2), pp.47-56.
22. Munoz, M., García-Erce, J.A. and Remacha, Á.F., 2011. Disorders of iron metabolism. Part 1: molecular basis of iron homoeostasis. Journal of clinical pathology, 64(4), pp.281-286.
23. Musallam, K.M., Tamim, H.M., Richards, T., Spahn, D.R., Rosendaal, F.R., Habbal, A., et al., 2011. Preoperative anaemia and postoperative outcomes in non-cardiac surgery: a retrospective cohort study. The Lancet, 378(9800), pp.1396-1407.
24. Richards, T., Clevenger, B., Keidan, J., Collier, T., Klein, A.A., Anker, S.D., et al., 2015. Preventt: preoperative intravenous iron to treat anaemia in major surgery: study protocol for a randomised controlled trial. Trials, 16, pp.1-6.

25. Safiri, S., Kolahi, A.A., Noori, M., Nejadghaderi, S.A., Karamzad, N., Bragazzi, N.L., et al., 2021. Burden of anemia and its underlying causes in 204 countries and territories, 1990–2019: results from the Global Burden of Disease Study 2019. Journal of hematology & oncology, 14, pp.1-16.
26. Shander, A., 2014. Preoperative anemia and its management. Transfusion and Apheresis Science, 50(1), pp.13-15.
27. Sim, Y.E., Wee, H.E., Ang, A.L., Ranjakunalan, N., Ong, B.C. and Abdullah, H.R., 2017. Prevalence of preoperative anemia, abnormal mean corpuscular volume and red cell distribution width among surgical patients in Singapore, and their influence on one year mortality. PLoS One, 12(8), p.e0182543.
28. Staender, S., Fritsch, G., Hinkelbein, J., Afshari, A., Bettelli, G., Bock, M., et al., 2018. Pre-operative evaluation of adults undergoing elective noncardiac surgery: updated guideline from the European Society of Anaesthesiology. European Journal of Anaesthesiology| EJA, 35(6), pp.407-465.
29. Tibi, P., McClure, R.S., Huang, J., Baker, R.A., Fitzgerald, D., Mazer, C.D., et al., 2021. STS/SCA/AmSECT/SABM update to the clinical practice guidelines on patient blood management. The Journal of ExtraCorporeal Technology, 53(2), pp.97-124.
30. Turner, J., Parsi, M. and Badireddy, M., 2024. Anemia.[Updated 2023 Aug 8]. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing.
31. White, M.C., Longstaff, L. and Lai, P.S., 2017. Effect of pre-operative anaemia on post-operative complications in low-resource settings. World journal of surgery, 41, pp.644-649.
32. World Health Organization, 2011. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Vitamin and Mineral Nutrition Information System.
33. World Health Organization, 2017. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Geneva, Switzerland: WHO, 2011 [online]
34. World Health Organization. Department of Child and Adolescent Health, 2005. Handbook IMCI: integrated management of childhood illness. World Health Organization.
35. Yan, T., Lei, S., Zhou, B., Huang, Y., Li, X., Zhang, J., et al., 2023. Association between preoperative anemia and postoperative short-term outcomes in patients undergoing colorectal cancer surgery-a propensity score matched retrospective cohort study. BMC anesthesiology, 23(1), p.307.
36. Yong, P.S.A., Ke, Y., Kok, E.J., Tan, B.P., Kadir, H.A. and Abdullah, H.R., 2024. Preoperative anemia in older individuals undergoing major abdominal surgery is associated with early postoperative morbidity: a prospective observational study. Canadian Journal of Anesthesia/Journal canadien d'anesthésie, 71(3), pp.353-366.
37. Zhang, F.Q., Yang, Y.Z., Li, P.F., Ma, G.R., Zhang, A.R., Zhang, H. et al., 2024. Impact of preoperative anemia on patients undergoing total joint replacement of lower extremity: a systematic review and meta-analysis. Journal of Orthopaedic Surgery and Research, 19(1), p.249.

8. ANNEXES

7.1. INFORMATION SHEET AND INFORMED VOLUNTARY CONSENT FORM FOR HOSPITAL ADMINISTRATIONS

My name is Dr. Abdulmejid Gudu. I am the principal investigator of the study to be conducted in Hiwot Fana comprehensive specialized hospital and Jugal general hospital. I am studying Anesthesiology, Critical Care and Pain Medicine at Haramaya University, College of Health and Medical Science. I kindly request you to lend me your attention to explain about this study.

The Study Title: The study title is "Magnitude and associated factors of preoperative anemia among adult elective surgical patients at public hospitals of Harar, Eastern Ethiopia"

The purpose/Aim of the Study: The purpose of this study is to establish a local institution based information on the prevalence and associated factors of preoperative anemia among adult elective surgical patients at public hospitals of Harar, Eastern Ethiopia. The finding of this study will provide up-to-date information for the health professionals working in Hiwot Fana Comperhensive Specialized Hospital and Jugal Regional Hospital. The finding of this study will provide information on the depth of the problem and guidance indeveloping preventive interventions. Also will serve as entry point for future studies. Moreover, the main aim of this study is to write a thesis as a partial fulfillment of my training in anesthesiology, Critical Care and pain medicine.

Procedure and Duration: the medical chart of adult elective surgical patients will be reviewed using preformed data abstraction form.

There are 33 listed items to be filled and the chart review for each participant will take about 30 minutes.

Risk and Benefit: The risk of participating in this study is minimal. The investigator will not pay any direct cash for study participants for participating in this study.

Confidentiality: Participant's information will be confidential. The finding of the study will be general for surgical patients and will not reflect anything about particular individual information. The data abstraction form will be coded with a unique identification number to exclude showing names. No reference will be made in oral or written reports that could link participants in the study.

Rights: You have, therefore, a full right to permit or not for this research to be done in this hospital. If you decide to permit you have again the right to stop the study whenever you notice violation of research ethics.

Contact Address: If you have any questions or inquiries about the study any time you can contact the principal investigator by using mobile phone number: **0912458009 or 0974551675 / Dr. Abdulmejid Gudu and/or E-mail:** **abdulmejidfeid@gmail.com** or the Institutional Health Research Ethics Review Committee of the College of Health and Medical Sciences using their office phone number: +251-254-662-011 or P.O.Box: 235, Harar, Ethiopia.

Declaration of Informed Voluntary Consent

I have read the participant information sheet. I have clearly understood the purpose of the study, the procedure, the risk and benefit of the study, and issues of confidentiality. The contact address was given to me for any queries. I have been given the opportunity to ask questions about things that have been unclear. I understand that participant has the right to withdraw from the study at any time or not to answer any question that they do not want and also I was informed that i have a full right to permit or not for this research to be done or not in this hospital. Therefore, I declare my voluntary on behalf of the Hospital Management to allow this study to be conducted in our Hospital with my signature.

Name of the hospital Manager: _____Signature:_____Date: ____/____/2023

Name of the Principal Investigator: _____Signature: _____Date: __/___/2023

7.2. DATA ABSTRACTION CHEKLIST

Part 1: Socio-demographic characteristics

No	Variables	Response and codes
101	Age	_____ (in years)
102	Sex	01. Male 02. Female

Part 2: Preoperative clinical characterstics

No.	Clinical Condition	Response and codes
201.	WBC	
202.	Recent Hb	_____ in g/dl
203.	Recent Hct	_____ in %
204.	Platlet count	
305.	MCV	
206.	Imaging findings	
207.	Duration of illness (The surgical condition)	
208.	Recent prior surgery	01. No 02. Yes
209.	Uses of medication	01. No 02. Yes (specify) _____
211.	Type of planned surgery .	Specify in details _____ _____
212.	Any diagnosed comorbidity	Specify) _____ _____
213.	Recent blood loss history	

Part 3: Nutritional and infection related factors

No.	Items	Responses and codes
301.	Weight	_____kg
302.	Height	_____cm
303.	BMI (if calculated)	_____kg/m^2
304.	Malaria	01. No 02. Yes
305.	Intestinal parasitosis	01. No 02. Yes

Part 4: Chronic condition related factors

No.	Items	Responses and codes
401.	Malignancy	01. No 02. Yes
402.	HIV	01. No 02. Yes
403.	Renal diseases	01. No 02. Yes
404.	Asthma	01. No 02. Yes
405.	PUD	01. No 02. Yes
406.	ASA Physical status	01. I 02. II 03. III

		04. IV 05. V
407.	DM	01. No 02. Yes
408.	Smoking	01. No 02. Yes
409.	Alcohol drinking	01. No 02. Yes
410.	Chat chewing	01. No 02. Yes

7.3. CURRICULUM VITAE

DR. ABDULMEJID GUDU JEMAL

Harar, Ethiopia

0912458009 | abdulmejidfeid@gmail.com

OBJECTIVE

To work in an environment which encourages me to succeed and grow professionally where I can utilize my skills and knowledge maximally.

EXPERIENCE

Warder Hospital
2010 - 2011
General practitioner
Hired as a GP but, additionally I have worked in several areas like leishmaniasis focal person and Quality improvement director.
Haramaya University
2011 - 2015
Lecturer
Worked as general practitioner, lecturer and CBTP & Internship coordinator. I have worked as a delegate for the head of school of medicine on several occasions. I was a member and active participant of different ad-hoc and standing committees of the college.
2015 – present
Resident
Anesthesiology, Critical Care and Pain Medicine

EDUCATION

Eshet primary school
2005
Primary school
Grade 8
Addis Ketama Preparatory school
2009
High school
Grade 12
Haramaya University
2017
Medical doctorate degree

TRAININGS

Enhancing clinical research skills: Bioethics, Data Quality, Statistical Analysis and Research write up October 29-31, 2025, Addis Ababa, Spanish cooperation in partnership with the Italian cooperation and European Union.

SKILLS

Basic computer skills, STATA statistical software and swimming.

ACHIEVEMENTS & AWARDS

Instituted systems and procedures for medical interns' information handling at HU, CHMS, school of medicine. Participated in HU, CHMS, SOM undergraduate medical curriculum amendment.Took several work related basic trainings.

INTERESTS

Participation in social activities
Visiting natural and historical places

ACTIVITIES

Watching football.

LANGUAGES

Amharic
English
Guragigna

PERSONAL DETAILS

Marital Status: Married
Nationality: Ethiopian
Religion: Muslim
Gender: Male
Place of birth: Addis Ababa

REFERENCE

Dr. Nathan Muluberhan (Haramaya University)
Assistant professor of emergency and critical care medicine
natan.muluberhan@haramaya.edu.et
0902474000
Dr. Tofik Abdella (Haramaya University)
Assistant professor of psychiatry
tofabdela2gmail.com
0920016898

I Undersigned the above information is true and explains about me. I can submit all my credentials I will be entitled to do so.

Dr. Abdulmejid Gudu