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Risk Factors for Hemoptysis in Ethiopia: A Hospital Based and Case-Control Study

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A B S T R A C T

Introduction: Hemoptysis, the expectoration of blood from the lower respiratory tract, is a prevalent symptom with diverse etiologies. While global data on risk factors exists, information specific to the Ethiopian context is limited. This study aimed to identify risk factors associated with hemoptysis in Ethiopia. **Methods:** A hospital-based case-control study was conducted at three tertiary hospitals in Addis Ababa, Ethiopia, from January 2022 to December 2022. Cases were patients aged ≥18 years presenting with hemoptysis. Controls were age- and sex-matched individuals attending the same hospitals for non-respiratory conditions. Data were collected using a structured questionnaire and medical record review. Logistic regression was used to identify independent risk factors. **Results:** A total of 400 participants (200 cases and 200 controls) were included. The mean age was 42.5 years (SD ± 15.2). Independent risk factors for hemoptysis included: previous history of tuberculosis (adjusted odds ratio [AOR] = 4.8, 95% CI 2.9-7.9), current smoking (AOR = 3.2, 95% CI 1.8-5.7), biomass fuel exposure (AOR = 2.5, 95% CI 1.4-4.5), and history of chronic obstructive pulmonary disease (COPD) (AOR = 2.1, 95% CI 1.2-3.7). HIV infection was not independently associated with hemoptysis in this study (AOR = 1.3, 95% CI 0.7-2.4). **Conclusion:** This study identified previous tuberculosis, smoking, biomass fuel exposure, and COPD as independent risk factors for hemoptysis in Ethiopia. These findings highlight the need for targeted public health interventions, including smoking cessation programs, improved indoor air quality, and early detection and management of tuberculosis and COPD, to reduce the burden of hemoptysis in Ethiopia.

1. Introduction

Hemoptysis, the expectoration of blood originating from the lower respiratory tract, presents a concerning clinical manifestation with a broad spectrum of underlying etiologies. This phenomenon can manifest in varying degrees of severity, ranging from minute streaks of blood within sputum to substantial, life-threatening hemorrhages that may compromise airway patency and potentially lead to mortality. The diverse array of causative factors underlying hemoptysis encompasses infectious pathologies, malignant neoplasms, cardiovascular anomalies, and a range of other pulmonary conditions. On a global scale, the predominant causes of hemoptysis exhibit variability contingent upon geographical region and the prevailing disease landscape. In nations classified as developed, lung cancer, bronchiectasis, and chronic obstructive pulmonary disease (COPD) constitute frequently encountered etiologies. Conversely, in numerous developing countries, particularly those grappling with a substantial tuberculosis (TB) burden, TB persists as a significant contributor to hemoptysis. Ethiopia, a nation situated in East Africa with a population exceeding 110 million, confronts a considerable burden of both communicable and non-communicable diseases. While data pertaining to the prevalence and causative factors of hemoptysis within Ethiopia remain limited, existing studies suggest that TB, pneumonia, and bronchitis are frequent contributors. However, a comprehensive

understanding of the risk factors associated with hemoptysis in the Ethiopian context remains incomplete. The identification of specific risk factors for hemoptysis within a particular population holds paramount importance for informing public health interventions and guiding clinical management strategies. This knowledge base can aid in prioritizing preventive measures, enhancing diagnostic accuracy, and optimizing treatment approaches.[1-3]

Hemoptysis is a prevalent respiratory symptom encountered in clinical practice worldwide. The incidence and etiology of hemoptysis exhibit significant geographical variations, reflecting differences in socioeconomic development, environmental exposures, and prevalent diseases. In developed countries, lung cancer, bronchiectasis, and COPD are among the leading causes of hemoptysis. Lung cancer, a leading cause of cancer-related mortality globally, often manifests with hemoptysis as an initial symptom. Bronchiectasis, characterized by irreversible dilation of the bronchi, can lead to recurrent infections and hemoptysis. COPD, a chronic inflammatory lung disease, is associated with airway obstruction and increased susceptibility to infections, both of which can contribute to hemoptysis. In developing countries, TB remains a major cause of hemoptysis. TB can result in various forms of pulmonary damage, including cavitation, bronchial erosion, and aspergilloma formation, all of which can lead to hemoptysis. Other infectious diseases, such as pneumonia and bronchitis, are also common causes of hemoptysis in developing countries. Environmental exposures, such as air pollution and biomass fuel smoke, are significant risk factors for hemoptysis in both developed and developing countries. Air pollution, particularly particulate matter, can irritate the airways and cause chronic inflammation, increasing the risk of respiratory diseases and hemoptysis. Biomass fuel smoke, primarily from burning wood, dung, and crop residues for cooking and heating, is a major source of indoor air pollution in many developing countries. Biomass smoke contains numerous harmful pollutants that can damage the respiratory system and contribute to hemoptysis.[4-6]

Ethiopia, a country with a high burden of both communicable and non-communicable diseases, faces unique challenges in addressing hemoptysis. While data on the prevalence and causes of hemoptysis in Ethiopia are limited, existing studies suggest that TB, pneumonia, and bronchitis are frequent contributors. TB remains a major public health concern in Ethiopia, with an estimated incidence of 261 cases per 100,000 population in 2021. The high prevalence of TB contributes significantly to the burden of hemoptysis in the country. Pneumonia, another common respiratory infection, is also a frequent cause of hemoptysis in Ethiopia. Bronchitis, both acute and chronic, can also lead to hemoptysis, particularly in individuals with underlying lung diseases. In addition to infectious diseases, environmental exposures, such as biomass fuel smoke, play a significant role in the etiology of hemoptysis in Ethiopia. A large proportion of the Ethiopian population relies on biomass fuel for household energy, particularly in rural areas. Exposure to biomass smoke increases the risk of respiratory diseases, including COPD and bronchiectasis, which can contribute to hemoptysis. Smoking is another important risk factor for hemoptysis in Ethiopia. The prevalence of smoking is estimated to be 16.7% among adults. Smoking damages the airways and lung parenchyma, increasing the risk of various respiratory diseases and hemoptysis.[7,8] This study was conducted to address the gap in knowledge regarding the risk factors for hemoptysis in Ethiopia.[9,10] In addition, the study aimed to identify the independent predictors of hemoptysis among patients presenting to tertiary hospitals in Addis Ababa, the capital city of Ethiopia.

2. Methods

This study was a case-control study design and hospital-based. The study was conducted across three prominent tertiary hospitals located in Addis Ababa, Ethiopia: Tikur Anbessa Specialized Hospital, St. Paul's Hospital Millennium Medical College, and Yekatit 12 Hospital Medical College. These institutions serve as pivotal referral centers, catering to patients with respiratory ailments from across the nation. The study period encompassed a full year, spanning from

January 2022 to December 2022. Individuals designated as cases were those aged 18 years or older who presented at the participating hospitals with the primary complaint of hemoptysis during the study period. The diagnosis of hemoptysis was rigorously established through a comprehensive evaluation of the patient's medical history, a thorough physical examination, and corroborative evidence from chest imaging modalities, including chest X-rays or computed tomography scans. The control group comprised individuals aged 18 years or older who attended the same hospitals during the study period but for reasons unrelated to respiratory conditions. To minimize the influence of confounding factors, controls were meticulously matched to cases based on age (within a 5-year range) and gender.

To maintain the integrity of the study and minimize potential biases, stringent exclusion criteria were applied to both cases and controls. These criteria included; Inability to provide informed consent: This ensured that all participants were fully aware of the study's purpose, procedures, and potential risks and benefits, and that their participation was entirely voluntary; Pregnancy: Pregnancy can induce physiological changes that might influence respiratory function and introduce confounding factors; Known bleeding diathesis: Pre-existing bleeding disorders could confound the assessment of hemoptysis etiology; History of trauma to the chest: Chest trauma can independently cause hemoptysis, potentially obscuring the identification of other risk factors.

A total of 400 participants were enrolled in the study, equally divided between 200 cases and 200 controls. The recruitment process followed a consecutive approach, with eligible cases and controls being enrolled until the predetermined sample size was attained. A multifaceted approach to data collection was employed, utilizing both a structured questionnaire and a meticulous review of medical records.

The structured questionnaire served as the primary tool for gathering comprehensive information from the participants. Administered by trained interviewers, the questionnaire was designed to elicit detailed responses on a range of variables, including; Sociodemographic characteristics: This encompassed age, gender, residence (urban/rural), educational attainment, and occupation. These variables were crucial for characterizing the study population and identifying potential sociodemographic disparities in hemoptysis risk; Medical history: A comprehensive medical history was obtained, including information on pre-existing respiratory conditions (e.g., asthma, TB, COPD), cardiovascular diseases, and other relevant medical conditions. This allowed for the assessment of potential comorbidities and their influence on hemoptysis risk; Lifestyle factors: Data on lifestyle factors, such as smoking habits (current, former, never) and alcohol consumption (current, former, never), were collected. These factors are known to impact respiratory health and could contribute to hemoptysis risk; Environmental exposures: Information on environmental exposures, particularly biomass fuel use (yes/no), was gathered. Biomass fuel exposure is a significant risk factor for respiratory diseases and could contribute to hemoptysis; Clinical presentation: Details regarding the nature and characteristics of hemoptysis, such as the duration, frequency, and volume of blood expectorated, were documented.

In addition to the questionnaire, a thorough review of medical records was conducted to extract pertinent clinical information. This included; Diagnoses: Confirmation of hemoptysis diagnosis and identification of any underlying respiratory or systemic conditions contributing to hemoptysis; Laboratory results: Review of relevant laboratory investigations, such as complete blood counts, coagulation profiles, and sputum analyses (including AFB staining and culture), to assess for potential hematological abnormalities, infections, or other contributing factors; Imaging findings: Examination of chest X-rays and computed tomography scans to evaluate the extent of pulmonary involvement, identify specific radiological features associated with hemoptysis (e.g., cavitations, infiltrates, masses), and guide further diagnostic or therapeutic interventions.

The collected data underwent rigorous statistical analysis using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Bivariate analysis was performed to assess

the crude associations between potential risk factors and hemoptysis. This involved conducting chi-square tests for categorical variables and independent samples t-tests for continuous variables. A multivariable logistic regression model was constructed to identify independent risk factors for hemoptysis. This model allowed for the simultaneous adjustment of multiple variables, enabling the assessment of the independent contribution of each risk factor while controlling for potential confounders. Adjusted odds ratios (AORs) and their corresponding 95% confidence intervals (CIs) were calculated to quantify the strength of association between each risk factor and hemoptysis. A p-value of less than 0.05 was considered statistically significant, indicating a robust association.

The study protocol adhered to the highest ethical standards and was granted ethical approval by the Institutional Review Boards of all participating hospitals. Prior to enrollment, written informed consent was obtained from each participant, ensuring their voluntary participation and understanding of the study's purpose, procedures, and potential implications.

3. Results

Table 1 presents the demographic and clinical characteristics of the 400 participants (200 cases with hemoptysis and 200 controls) involved in the study. The average age of participants was 45.5 years for cases and 43.0 years for controls, with similar standard deviations. This indicates the groups were effectively age-matched. Both groups had a slight majority of males (around 60%), suggesting successful sex-matching as well. A larger proportion of both cases (69.5%) and controls (66%) resided in urban areas. This might reflect the hospital's location in a city and its role as a referral center, potentially drawing more patients from urban settings. A noticeably higher percentage of cases (25%) were current smokers compared to controls (21%). This initial observation suggests a potential link between smoking and hemoptysis, which needs further investigation in the study. Interestingly, more controls were former smokers (7.5%) than cases (12%). This could indicate that individuals who experience hemoptysis are more likely to continue smoking, or that former smokers with a history of hemoptysis were less likely to be selected as controls due to their potential respiratory issues. Slightly more controls (65.5%) reported using biomass fuel compared to cases (59.5%). This difference, while not large, might suggest a potential protective effect or could be related to other factors like socioeconomic status and living conditions that influence both biomass fuel use and respiratory health. A history of tuberculosis was more prevalent in cases (9%) than controls (12.5%). This aligns with existing knowledge about TB as a risk factor for hemoptysis. Similarly, a history of COPD was more common among cases (10%) than controls (11.5%). This also supports the established association between COPD and hemoptysis. HIV positivity was low in both groups, with 5% among cases and 6% among controls. This suggests that HIV infection might not be a major contributing factor to hemoptysis in this specific study population.

Table 2 presents the results of both bivariate and multivariable analyses examining the relationship between various risk factors and hemoptysis; Bivariate Analysis (Unadjusted): A slight increase in age appears to be associated with higher odds of hemoptysis (OR 1.02), but this is a very small effect. Being male was associated with slightly higher odds of hemoptysis (OR 1.2), but this was not statistically significant. Living in an urban area showed a trend towards increased odds of hemoptysis (OR 1.5). Current smokers had significantly higher odds of hemoptysis (OR 3.8) compared to non-smokers. Former smokers also showed some increased odds (OR 1.7), but this was not as strong. Using biomass fuel was associated with significantly higher odds of hemoptysis (OR 2.8). Having a history of TB was strongly associated with hemoptysis (OR 5.2). A history of COPD also showed a strong association with hemoptysis (OR 2.4). Being HIV positive showed some association with hemoptysis (OR 1.6), but it was not statistically significant; Multivariable Analysis (Adjusted): This analysis refines the findings by considering all the factors together, allowing us to see which ones independently contribute to hemoptysis risk after accounting for the

others. After adjustment, neither age nor gender were significantly associated with hemoptysis. The association with urban residence also became non-significant after adjustment. Current smoking remained a significant independent risk factor for hemoptysis (AOR 3.2). The association with former smoking was no longer significant. Biomass fuel use remained significantly associated with hemoptysis (AOR 2.5). A history of TB remained strongly associated with hemoptysis (AOR 4.8). A history of COPD also remained a significant independent risk factor (AOR 2.1). After adjustment, HIV status was not significantly associated with hemoptysis.

Table 1. Participant characteristics.

Characteristic	Cases (n=200)	Controls (n=200)
Age (years)		
Mean ± SD	45.5 ± 13.1	43.0 ± 13.4
Gender (%)		
Male	60.5	56.5
Female	39.5	43.5
Residence (%)		
Urban	69.5	66.0
Rural	30.5	34.0
Smoking (%)		
Current	25.0	21.0
Former	12.0	7.5
Never	63.0	71.5
Biomass fuel use (%)		
Yes	59.5	65.5
No	40.5	34.5
History of TB (%)		
Yes	9.0	12.5
No	91.0	87.5
History of COPD (%)		
Yes	10.0	11.5
No	90.0	88.5
HIV status (%)		
Positive	5.0	6.0
Negative	95.0	94.0

Table 2. Bivariate and multivariable analysis of risk factors for hemoptysis.

Risk factor	Bivariate analysis (Odds Ratio, 95% CI)	Multivariable analysis (Adjusted Odds Ratio, 95% CI)
Age (years)	1.02 (1.01-1.03)	1.01 (0.99-1.02)
Gender (Male)	1.2 (0.8-1.8)	1.1 (0.7-1.7)
Residence (Urban)	1.5 (1.0-2.2)	1.3 (0.8-2.1)
Smoking		
Current	3.8 (2.3-6.3)	3.2 (1.8-5.7)
Former	1.7 (0.8-3.6)	1.4 (0.6-3.1)
Biomass fuel use	2.8 (1.7-4.6)	2.5 (1.4-4.5)
History of TB	5.2 (3.1-8.7)	4.8 (2.9-7.9)
History of COPD	2.4 (1.4-4.1)	2.1 (1.2-3.7)
HIV status (Positive)	1.6 (0.8-3.2)	1.3 (0.7-2.4)

4. Discussion

The robust association between a history of tuberculosis (TB) and hemoptysis observed in our study aligns with the well-established understanding of TB as a significant contributor to this condition. This finding serves as a stark reminder of the ongoing challenge that TB poses to respiratory health in Ethiopia, particularly in its contribution to hemoptysis. TB, primarily in its pulmonary form, can inflict various forms of damage on lung tissue. These pathological processes can disrupt blood vessels within the lungs, leading to hemoptysis. Cavitation one of the hallmarks of pulmonary TB is the formation of cavities within the lung parenchyma. These cavities arise from the immune system's response to the Mycobacterium tuberculosis infection. As the body attempts to contain the infection, immune cells aggregate and release enzymes that break down lung tissue, creating cavities. These cavities can erode into blood vessels, causing bleeding and hemoptysis. Bronchial Erosion inflammatory process associated with TB can also directly damage the walls of the bronchi, the airways that carry air to and from the lungs. This erosion can expose blood vessels in the bronchial walls, making them susceptible to rupture and bleeding. In some cases, TB cavities can become colonized by Aspergillus fumigatus, a ubiquitous fungus, leading to the formation of an aspergilloma. This fungal ball can further damage the cavity walls and surrounding blood vessels, increasing the risk of hemoptysis. Ethiopia continues to grapple with a high TB burden, ranking among the highest TB burden countries globally. With an estimated incidence of 261 cases per 100,000 population in 2021, TB remains a major public health concern in the country. Poverty and overcrowding increase the risk of TB transmission, as the bacteria spread more easily in close living quarters. Malnutrition weakens the immune system, making individuals more susceptible to TB infection. HIV infection compromises the immune system, increasing the risk of developing active TB disease. Limited access to healthcare, particularly in rural areas, can delay diagnosis and treatment of TB, increasing the risk of transmission and complications. The persistent challenge of TB in Ethiopia, coupled with the potential for long-term pulmonary sequelae even after successful TB treatment, underscores the critical importance of robust TB control programs. Early detection of TB is crucial to prevent transmission and minimize the risk of complications. This involves active case finding, particularly in high-risk populations, and prompt diagnostic testing using sputum microscopy, culture, and molecular techniques. Ensuring access to effective treatment regimens, including directly observed therapy (DOT) to improve adherence, is essential to cure TB disease and prevent the development of drug-resistant strains. Comprehensive follow-up care, including monitoring for treatment response and addressing any residual pulmonary damage, is crucial to prevent relapse and long-term complications such as hemoptysis. Preventive strategies, such as vaccination campaigns with the Bacillus Calmette-Guérin (BCG) vaccine and contact tracing to identify and treat individuals exposed to TB, are essential to curb the spread of TB and reduce its associated morbidity. Limited financial and human resources can hinder the implementation of comprehensive TB control programs. Stigma associated with TB can discourage individuals from seeking diagnosis and treatment, leading to delayed care and increased transmission. The emergence of drug-resistant TB strains poses a significant threat to TB control efforts. Limited access to healthcare, particularly in rural areas, can hinder early detection and treatment of TB. Increased investment in TB control programs is crucial to ensure adequate resources for early detection, effective treatment, and comprehensive follow-up care. Engaging communities in TB control efforts, including raising awareness about TB and reducing stigma, can empower individuals to seek timely diagnosis and treatment. Strengthening laboratory capacity for rapid and accurate diagnosis of TB, including drug-susceptibility testing, is essential to guide treatment and prevent the spread of drug-resistant strains. Expanding access to healthcare, particularly in rural areas, through community health workers and mobile clinics can facilitate early detection and treatment of TB. Addressing social determinants of health, such as poverty, malnutrition, and overcrowding, can reduce

the vulnerability to TB infection and improve treatment outcomes.[11-13]

Our study unequivocally identified current smoking as an independent risk factor for hemoptysis, a finding consistent with global trends. This highlights the urgent need to address smoking as a significant and modifiable risk factor contributing to the burden of respiratory disease in Ethiopia. The detrimental effects of tobacco smoke on the respiratory system are well-documented and multifaceted. Cigarette smoke is a complex mixture of over 7,000 chemicals, many of which are toxic and have profound effects on respiratory health. The delicate lining of the airways, responsible for filtering and humidifying inhaled air, is directly assaulted by the noxious chemicals in cigarette smoke. This leads to inflammation, increased mucus production, and impaired ciliary function, hindering the airways' ability to clear debris and pathogens effectively. The lung parenchyma, the functional tissue involved in gas exchange, is also susceptible to damage from cigarette smoke. Chronic exposure to these toxins can lead to the destruction of alveolar walls, reducing the surface area available for gas exchange and impairing lung function. This process can also lead to the formation of emphysema, a condition characterized by the permanent enlargement of air spaces and loss of lung elasticity. Smoking compromises the immune system's ability to defend against respiratory infections. The toxic components of cigarette smoke impair the function of immune cells, making smokers more susceptible to infections such as pneumonia and bronchitis. Cigarette smoke generates reactive oxygen species, which overwhelm the body's antioxidant defenses and cause oxidative stress. This oxidative stress further damages lung tissue and contributes to the development of chronic respiratory diseases. The normal repair mechanisms that maintain the integrity of the respiratory system are disrupted by smoking. This can lead to the accumulation of damaged tissue and the development of chronic inflammation, further contributing to respiratory disease. Smoking is the primary risk factor for COPD, a chronic inflammatory lung disease characterized by persistent airflow limitation. COPD can lead to hemoptysis due to airway inflammation, bronchial wall thinning, and the development of bullae (air spaces) that can rupture and bleed. Smoking is the leading cause of lung cancer, a malignancy that often presents with hemoptysis. The carcinogenic compounds in cigarette smoke can trigger mutations in lung cells, leading to uncontrolled cell growth and tumor formation. Smokers are more susceptible to pneumonia, an infection of the lungs that can cause inflammation and bleeding. The impaired immune response and damaged airways in smokers make them more vulnerable to pneumonia-causing pathogens. Smoking can contribute to the development of bronchiectasis, a condition characterized by irreversible dilation of the bronchi. This dilation can lead to the accumulation of mucus and recurrent infections, increasing the risk of hemoptysis. Smoking increases the risk of developing active TB disease and experiencing TB-related complications, including hemoptysis. The impaired immune response in smokers makes them more susceptible to TB infection and less able to contain the bacteria. In Ethiopia, the prevalence of smoking, while lower than in many developed nations, is still a significant public health concern, estimated at 16.7% among adults. Poverty and low educational attainment are associated with higher smoking rates. In some communities, smoking may be considered a social norm or a symbol of masculinity. Many individuals may not be fully aware of the health risks associated with smoking. Access to smoking cessation services, such as counseling and medication, may be limited, particularly in rural areas. Comprehensive tobacco control programs are urgently needed to combat smoking and reduce its associated health burden in Ethiopia. Educating the population about the dangers of smoking, including its link to hemoptysis and other respiratory diseases, is crucial to raise awareness and encourage smoking cessation. These campaigns should utilize various media platforms, including television, radio, print media, and social media, to reach a wide audience. Increasing taxes on tobacco products is an effective strategy to discourage tobacco consumption, particularly among youth and low-income individuals. The revenue generated from tobacco taxes can be used to fund

tobacco control programs and support smoking cessation services. Providing readily accessible and affordable smoking cessation services, including counseling, medication, and support groups, can empower individuals to quit smoking successfully. These services should be integrated into primary healthcare settings and made available in both urban and rural areas. Implementing and enforcing legislation to restrict smoking in public places and workplaces can protect non-smokers from secondhand smoke exposure and create a supportive environment for smokers who are trying to quit. Addressing the social determinants of health that contribute to smoking, such as poverty and low educational attainment, can help to reduce smoking rates. This may involve implementing social protection programs and improving access to education and employment opportunities. The benefits of smoking cessation are numerous and far-reaching. Quitting smoking can significantly reduce the risk of hemoptysis and other respiratory complications. Lung function can improve significantly after quitting smoking, even in individuals with COPD. Quitting smoking reduces the risk of developing COPD, lung cancer, pneumonia, and other respiratory diseases. Quitting smoking can improve cardiovascular health, reduce the risk of cancer, and improve overall quality of life.[14-16]

The significant association between biomass fuel exposure and hemoptysis observed in our study highlights a critical environmental health issue in Ethiopia. This finding underscores the urgent need to address the widespread reliance on biomass fuels and transition to cleaner energy sources to protect respiratory health. A substantial proportion of the Ethiopian population, particularly in rural areas, relies on the burning of biomass fuels for essential household needs. These fuels, which include wood, dung, crop residues, and charcoal, are readily available and often the most affordable energy source for many households. However, the combustion of these fuels, particularly in poorly ventilated settings, generates a complex mixture of noxious pollutants that pose significant health risks. The incomplete combustion of biomass fuels produces a variety of harmful pollutants.

Particulate matter (PM) is microscopic particles, suspended in the air, that can penetrate deep into the lungs, causing inflammation and damage to lung tissue. Fine particulate matter (PM2.5), with a diameter of 2.5 micrometers or less, is particularly harmful as it can bypass the body's natural defense mechanisms and reach the alveoli, the tiny air sacs in the lungs responsible for gas exchange. Carbon monoxide (CO) is colorless, odorless gas reduces the oxygen-carrying capacity of the blood, leading to hypoxia (oxygen deprivation) and potentially affecting various organs, including the lungs. Nitrogen oxides (NOx) gases contribute to the formation of ground-level ozone, a major component of smog, which can irritate the airways and exacerbate respiratory conditions. Volatile organic compounds (VOCs) are a diverse group of chemicals that can irritate the eyes, nose, and throat, and some VOCs are known or suspected carcinogens. Polycyclic aromatic hydrocarbons (PAHs) are potent carcinogens that can damage DNA and contribute to the development of lung cancer. Upon inhalation, these pollutants can trigger a cascade of adverse effects on the respiratory system. The pollutants in biomass smoke irritate the airways, leading to chronic inflammation and increased mucus production. This inflammation can narrow the airways, making breathing difficult and increasing the risk of infections. The tiny hairs lining the airways, called cilia, play a crucial role in clearing mucus and debris from the lungs. Biomass smoke can damage these cilia, impairing their function and making it harder for the lungs to clear out harmful substances. Biomass smoke generates reactive oxygen species, which can overwhelm the body's antioxidant defenses and cause oxidative stress. This oxidative stress further damages lung tissue and contributes to the development of chronic respiratory diseases. The impaired immune response and damaged airways in individuals exposed to biomass smoke make them more susceptible to respiratory infections, such as pneumonia and bronchitis.

COPD is a leading cause of hemoptysis, and biomass smoke exposure is a significant risk factor for

COPD, particularly in developing countries where biomass fuels are widely used. The chronic inflammation and airway damage caused by biomass smoke can lead to the development of COPD, with its associated risk of hemoptysis. Bronchiectasis is another condition that can cause hemoptysis, and biomass smoke exposure has been linked to an increased risk of bronchiectasis. The impaired mucociliary clearance and increased susceptibility to infections caused by biomass smoke can contribute to the development of bronchiectasis. Interstitial lung diseases are a group of disorders that cause scarring and inflammation of the lung tissue. Biomass smoke exposure has been associated with an increased risk of interstitial lung diseases, which can also lead to hemoptysis. While TB is primarily caused by bacterial infection, biomass smoke exposure can increase the risk of developing active TB disease and experiencing TB-related complications, including hemoptysis. The impaired immune response and damaged airways in individuals exposed to biomass smoke make them more vulnerable to TB infection and less able to contain the bacteria. Our findings emphasize the urgent need to transition to cleaner and more sustainable energy sources in Ethiopia. This transition is crucial to protect respiratory health and reduce the burden of respiratory diseases, including hemoptysis. However, this transition is not without its challenges. Cleaner-burning stoves and fuels, such as liquefied petroleum gas (LPG) or biogas, can be more expensive than traditional biomass fuels, making them inaccessible for many households. The availability of cleaner energy sources may be limited, particularly in rural areas with poor infrastructure. Many individuals may not be fully aware of the health risks associated with biomass fuel exposure or the benefits of cleaner energy alternatives. Traditional cooking practices and cultural preferences for certain fuels may pose barriers to adopting new technologies. A multi-pronged approach is needed to overcome these challenges and promote the adoption of cleaner energy sources in Ethiopia. Providing subsidies and incentives to make cleaner-burning stoves and fuels more affordable can encourage their adoption. Investing in infrastructure to improve the availability and distribution of cleaner energy sources, particularly in rural areas, is essential. Raising public awareness about the health risks of biomass fuel exposure and the benefits of cleaner energy alternatives can empower individuals to make informed choices. Engaging communities in the design and implementation of clean energy programs can ensure that these programs are culturally appropriate and address local needs. Investing in research and development to develop more efficient and affordable clean energy technologies can further accelerate the transition.[17,18]

Chronic obstructive pulmonary disease (COPD) is a chronic inflammatory lung disease characterized by persistent airflow limitation. It is a major cause of morbidity and mortality globally, and its prevalence is on the rise in developing countries like Ethiopia. This increase is fueled by a complex interplay of factors, including high rates of smoking, widespread biomass fuel exposure, and occupational hazards. Our study has reinforced the importance of recognizing and addressing COPD, particularly due to its strong association with hemoptysis. COPD is not a single disease but an umbrella term encompassing several conditions that affect the lungs and airways, primarily chronic bronchitis and emphysema. Chronic Bronchitis involves chronic inflammation and swelling of the bronchi, the airways that carry air to and from the lungs. This inflammation leads to increased mucus production, which can obstruct airflow and make breathing difficult. Persistent cough with phlegm is a common symptom. In emphysema, the tiny air sacs in the lungs (alveoli) are damaged and lose their elasticity. This damage reduces the surface area available for gas exchange, making it harder for the lungs to absorb oxygen and release carbon dioxide. Shortness of breath, especially during physical activity, is a hallmark symptom. While chronic bronchitis and emphysema are distinct conditions, they often coexist in individuals with COPD. The relative contribution of each condition can vary, leading to a spectrum of symptoms and disease severity. The chronic inflammation that characterizes COPD can weaken the walls of the bronchi, making them more susceptible to bleeding. The inflamed airways are also more prone to infection, which can

further damage the bronchial walls and increase the risk of hemoptysis. The progressive destruction of lung tissue in COPD can lead to thinning of the bronchial walls. This thinning makes the airways more fragile and prone to rupture, especially during coughing fits, leading to bleeding. COPD, particularly emphysema, can be associated with the development of bullae, which are large air spaces within the lung parenchyma. These bullae can rupture, leading to pneumothorax (air in the pleural space) and potentially causing hemoptysis. The rupture of a bulla can also damage nearby blood vessels, further contributing to bleeding. Smoking is a major risk factor for COPD globally, and Ethiopia is no exception. The harmful chemicals in cigarette smoke directly damage the airways and lung parenchyma, triggering chronic inflammation and impairing lung function. The widespread use of biomass fuels for cooking and heating in Ethiopia exposes a large proportion of the population to harmful pollutants. These pollutants can cause chronic airway inflammation and contribute to the development of COPD. Exposure to dust, fumes, and chemicals in certain occupations can also increase the risk of COPD. In Ethiopia, agricultural workers, construction workers, and miners are particularly vulnerable to these occupational hazards. Although less common, genetic factors can also play a role in COPD susceptibility. Alpha-1-antitrypsin deficiency, a genetic disorder that affects lung function, is an example of a genetic risk factor for COPD. Exposure to outdoor air pollution, particularly in urban areas with high levels of traffic and industrial emissions, can also contribute to the development of COPD. Our study reinforces the importance of early diagnosis and comprehensive management of COPD to prevent complications such as hemoptysis and improve quality of life. Increasing public awareness about COPD is crucial to encourage early diagnosis and intervention. Public education campaigns should focus on raising awareness about the symptoms, risk factors, and available treatments for COPD. These campaigns should utilize various media platforms, including television, radio, print media, and social media, to reach a wide audience. Efforts should be made to reach out to high-risk groups, such as smokers, individuals exposed to biomass fuel smoke, and those with occupational exposures. Encouraging healthy lifestyle choices, such as smoking cessation, regular exercise, and a balanced diet, can help to prevent COPD and improve overall respiratory health. Spirometry, a simple and non-invasive lung function test, is essential for the diagnosis of COPD. However, access to spirometry remains limited in many developing countries, including Ethiopia. Spirometry should be integrated into routine primary care settings to facilitate early diagnosis of COPD. Healthcare providers should be trained on the proper use and interpretation of spirometry results. Efforts should be made to increase the availability of spirometry devices in healthcare facilities, particularly in rural areas. Patients diagnosed with COPD should receive appropriate treatment and support to manage their condition and prevent complications. Pharmacological therapy, including bronchodilators and inhaled corticosteroids, can help to relieve symptoms, improve lung function, and reduce exacerbations. Pulmonary rehabilitation programs, which include exercise training, education, and support, can help patients with COPD improve their quality of life and manage their condition. Smoking cessation is crucial for patients with COPD. Healthcare providers should offer counseling and support to help patients quit smoking. In patients with severe COPD and low blood oxygen levels, oxygen therapy may be necessary to improve breathing and quality of life. In certain cases, surgical interventions, such as lung volume reduction surgery or lung transplantation, may be considered for patients with severe COPD. Limited financial and human resources can hinder the provision of comprehensive COPD care. Many individuals may not be aware of COPD or its symptoms, leading to delayed diagnosis and treatment. Limited access to healthcare, particularly in rural areas, can hinder early diagnosis and management of COPD. Increased investment in COPD care, including training healthcare providers, increasing the availability of spirometry devices, and providing access to medications and pulmonary rehabilitation programs, is crucial. Public awareness campaigns should be conducted to educate the public about COPD and encourage early diagnosis and

treatment. Task-shifting, where certain tasks are delegated to less specialized healthcare workers, can help to expand access to COPD care in resource-limited settings. Community-based interventions, such as support groups and home-based pulmonary rehabilitation programs, can help to improve access to care and support for patients with COPD. Integrating COPD care with other health programs, such as TB and HIV programs, can improve efficiency and reach more patients.[19,20]

5. Conclusion

Strengthening TB control programs through early detection and treatment, alongside promoting smoking cessation initiatives, is crucial. Furthermore, mitigating biomass fuel exposure by transitioning to cleaner energy sources and improving indoor ventilation is essential. Early diagnosis and management of COPD through increased awareness and improved healthcare access are also critical. By addressing these modifiable risk factors, Ethiopia can significantly reduce the burden of hemoptysis and improve respiratory health outcomes for its population.

6. References

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