Open Access Full Text Article   Check for updates   Research Article

Magnitude of anemia and associated factors among adults with tuberculosis in Galkaio Public Health Facilities Puntland, Somalia 2024: A cross-sectional study design

Mohyadin Abdullahi Ahmed [1]*, Abdulahi Said Diriye [1], Mustafe Abdi Ali [2], Beder Jama Yusuf [1]

[1] Department of Public Health, College of Medicine and Health Science, Jigjiga University, Jigjiga, Ethiopia
[2] Department of Statistics, institute Natural and Computational Science, Jigjiga University, Jigjiga, Ethiopia

Article Info:

*Address for Correspondence:

Mohyadin Abdullahi Ahmed, Department of Public Health, College of Medicine and Health Science, Jigjiga University, Jigjiga, Ethiopia

Abstract

Background: Anemia is associated with tuberculosis (TB) is a common condition that occurs when a person with TB has a reduced number of red blood cells, which can lead to fatigue, weakness, shortness of breath, and other symptoms. Anemia in TB can occur due to a variety of reasons, including nutritional deficiencies, chronic inflammation, and bone marrow suppression. The severity of anemia can vary depending on the stage and severity of TB infection, and it may worsen during TB treatment. Treatment of anemia associated with TB may involve addressing the underlying cause, such as improving nutrition or managing inflammation, and sometimes may require blood transfusions.

Objective: The objective of this study is to assess the magnitude of anemia and associated factors among adults with tuberculosis in Galkaio town Public Health Facilities Puntland, Somalia 2024.

Methods: A facility-based cross-sectional study was used. A total sample of 422 adults with tuberculosis include in this study. Attending Health facilities in Galkaio town. Systematic random sampling technique was used to select the study participants. Structured questionnaires were used to obtain information related to socio-demographic characteristics. Data from both questioner and laboratory were checked and cleaned for completeness and consistency. Data was entered into Epi data version 3.1 and was analyzed using Statistical Package for the Social Science (SPSS) Version 20 statistical software. Both bivariate with cut off < 0.25 and multivariate with cut off < 0.05 analysis has been used to check the strength of association between dependent and independent variables.

Result: The overall magnitude of anemia was 82.7% CI :(78.09, 86.31).In multivariable logistic regression analyses, the odds of anemia were 4.23 times higher for patients aged between 41-50 years [AOR=4.23, 95% CI (1.92,9.34)] compared to those aged between 18-30 years, 6.12 times higher for patients unable to read and write compared to those who had a college diploma and above [AOR=6.12, 95% CI (2.63,14.2)], and 5.71 times higher for patients who had not started taking Anti-TB drugs compared to those who had started [AOR=5.71, 95% CI (2.68,12.14)].

Conclusion: the magnitude of anemia among adults with tuberculosis in the study area was found to be high (82.7%). The study revealed that age, gender, occupation, TB treatment status, started taking Anti-TB drugs, and BMI as key factors associated with anemia. These findings underscore the importance of targeted interventions and healthcare strategies for at-risk individuals, with the aim of reducing the burden of anemia.

Keywords: Anemia, Adults, Tuberculosis, associated factors, Puntland state, Galkaio town, Somalia

INTRODUCTION

Anemia is a condition in which hemoglobin (Hgb) concentration and/or red blood cell (RBC) numbers are lower than normal and insufficient to meet an individual's physiological needs, affecting roughly one-third of the world's population. Anemia is associated with increased morbidity and mortality in women and children, poor birth outcomes, decreased work productivity in adults, and impaired cognitive and behavioral development in children[1].

Anemia is a common complication in tuberculosis (TB), affecting 30–94% of diagnosed TB patients. In addition, anemia has been linked to poor TB outcomes, such as delayed sputum conversion, higher mortality rates, and TB reoccurrence[2].

Pulmonary tuberculosis (PTB) is associated with chronic inflammation and anemia. Many patients with active pulmonary TB exhibit decreased levels of hemoglobin, which can directly impact TB-associated morbidity[3].

Mycobacterium TB bacilli are the primary cause of the exceedingly prevalent chronic infectious illness tuberculosis. Globally, Mycobacterium tuberculosis infection remains at an epidemic level, affecting one-third of the world population. Blood abnormalities are commonly associated with pulmonary tuberculosis[4] The hematopoietic system is the organ that is responsible for the formation of blood or blood cells. However, it is seriously affected by tuberculosis, which exerts dazzling A variety of hematological effects involving both cell lines and plasma components[5].

The hematological changes sometimes act as useful factors, providing a clue to diagnosis, assessing the prognosis, indicating the complication of the underlying infection, as well as therapy and response to therapy[5]. Anemia can develop as a secondary effect of a disease process that does not physically invade the bone marrow or markedly accelerate the destruction of erythrocytes. One of the most common infections causing anemia is tuberculosis; the extent of anemia associated with tuberculosis depends on the extension of the disease [6].The anemia takes several weeks to develop after the onset of infection and then progresses slowly over several months until the hemoglobin level eventually stabilizes[6].

WHO standards were used to define anemia. Anemia affected 75.2% of the TB patients, it was discovered. Females (80%) were more affected than males (20%). In TB patients, normocytic normochromic anemia was more common (64.8%) than microcytic hypochromic anemia. Malnourished TB patients have much greater anemia rates than healthy TB patients do. Anemia and TB symptoms, such as weight loss, coughing before diagnosis, duration of coughing, etc., were found to be significantly associated [7]. Anemia and TB are two of Somalia's worst public health issues. All age groups and both sexes are susceptible to anemia. Bleeding, long-term illnesses including tuberculosis, and cancer are major contributors to anemia development [7].

Deficiency anemia as well as anemia without iron deficiency in TB patients are related to a 2–3-fold increased risk of death. In TB patients, anemia could manifest as chronic disease-rrelated anemia, anemia due to coughing blood (hemoptysis), anemia due to malnutrition, or sideroblastic anemia as a side effect of isoniazid [8]. Autoimmune hemolytic anemia (AIHA) occurs when a patient produces pathologic antibodies that attach to and lead to the destruction of their RBCs, resulting in anemia. AIHA can be classified as warm AIHA or cold AIHA according to the characteristic temperature activity of the antibodies[9]. Iron deficiency anemia was associated with a nearly 2-fold independent increase in the risk of death in a randomized clinical trial in patients with pulmonary TB [10].

Anemia is a worldwide problem; it affects 24.8% of the population. Tuberculosis has become a double burden among anemic patients[11]. The prevalence of anemia of chronic disease (ACD) and iron deficiency anemia (IDA) is 49.82% and 20.17%, respectively. Hb levels are low when TB is diagnosed or as the illness progresses, which directly affects how well a patient respond to therapy and how they live their lives. and also that the prevalence of recurrent TB infection is high among individuals with low Hb levels [3] . There is strong evidence to suggest that anemia at the time of TB diagnosis is linked to a higher risk of death, and numerous studies have shown that anemia is quite prevalent among TB patients [32–86%] [12]. Anemia affects TB patients at a rate of between 30 to 94% [13, 14].

A recent systematic review and meta-analysis found that the risk of developing tuberculosis (TB) is dose-dependently correlated with the degree of anemia. Anemia is linked to a fourfold increased risk of developing TB[11]. Additionally, 62% of patients with TB are expected to have anemia, with mild, moderate, and severe anemia being present in 36%, 31%, and 12% of these individuals, respectively [15]. There are numerous factors that contribute to TB-associated anemia, including dietary deficiencies and the suppression of erythropoiesis by inflammatory markers [16]. Because it is linked to delayed sputum conversion, the high prevalence of anemia in TB is alarming[17]. Severe forms of TB (such as meningitis and disseminated disease) [18]. Several African countries have high rates of tuberculosis-related anemia, including Malawi (77%), Tanzania (86%), and Sudan (60%) [17, 19, 20].

Studies have indicated that anemia is linked to a poor prognosis and an increased risk of death in TB patients, and it has been demonstrated that anemia is an independent predictor of disease progression and death in TB patients[21]. The majority of patients with active TB had anemia, which was most likely brought on by inflammation rather than an iron deficit, given that TB treatment alone was sufficient to raise Hb levels[22].

In Somalia, there is no previous research related to the magnitude of TB-associated anemia. The aim of this study is to determine the magnitude of anemia and associated factors among adults with tuberculosis in Galkaio Town public health facilities in Puntland State, Somalia. Currently, there is limited research about the prevalence of anemia and associated factors in this population, and this study aims to fill this gap in knowledge by providing updated information on the prevalence and associated factors of anemia in adults with tuberculosis.

METHODS AND MATERIALS

Study Area

The study was conducted in Galkaio Town. Galkaio Town is located about halfway between Mogadishu and Bosaso; it is 700 km away from the capital city of Mogadishu. It is the capital of the north-central Mudug region of Somalia. According to the UNDP, it had a population of 750,667 in 2018. According to the Galkaio administration, the city has four health centers, one regional referral hospital, and several private clinics. The surrounding rural livelihood zones are Addun pastoral and Hawd pastoral. The livelihood of the community largely depends on livestock, trade, and the Somali Diaspora's remittances to their families.

Study Period

The Study was employed from 15 January to 15 May 2024.

Study Design

Facility- based cross sectional study design was used.

Source Population and Study Population

Source Population

All TB patient adults who were visiting public health facilities in Galkaio Town during the study period

Study population

All TB patient adults who were systematically selected from the public health facilities.

Eligibility criteria

Inclusion criteria

TB patients with Ages 18 years old and above visiting in public health facilities in Galkaio Town who were included after their consents approved.

Exclusion criteria

TB patients who were not able to respond to the interview because of seriously ill were excluded from the study.

Sample size determination

The sample size was calculated by using single population proportion formula considering, 95% confidence level, 5% margin of error, by taking 50% of the magnitude of anemia among TB patients no previous studies that clearly shows the prevalence of anemia among TB patient was done in the study area [23].

The assumptions are in below:

$$n = \frac{(Z\alpha)^2 \times P(1-P)}{d2}$$

Where,

n = the required sample size
P = the proportion of the anemic tuberculosis patients 50%
$Z\alpha$ = Z score at 95% confidence interval=1.96
d = Margin of error = 0.05

Accordingly, the sample size will be:

$$n = \frac{(1.96)2 \times 0.5\,(1-0.5)}{(0.05)2} = 384$$

Therefore, the total sample size was 422 after adding 10% non-respondent rate.

Sampling technique

By considering Galkaio Town, which consists of ten health facilities, both public and private, out of ten health facilities, five of them provide a service for TB patients, namely Galkaio General Hospital, Guryo-Samo Health Center, Hayat Private Hospital, Modern Private Hospital, and Awale Health Center. The calculated sample size and desired number of study participants were allocated proportionally for each health facility. A systematic random sampling procedure was used to select the study participants by calculating the k interval (N/n = 887/422 = 2) for every second TB patient enrolled in the study.

Sampling procedure

In selected health facilities, there was one general hospital, two health centers, and two private hospitals that provided services for TB patients. The number of study participants assigned to each health facility was proportional to the number of monthly clients. The number of TB patients in each health facility for three months was multiplied by the total sample size (n = 422), divided by the total number of TB patients in the entire public health facility. Finally, study subjects were selected using the systematic random sampling method (by taking every other patient), and the first sample was selected by the lottery method. Figure 1.
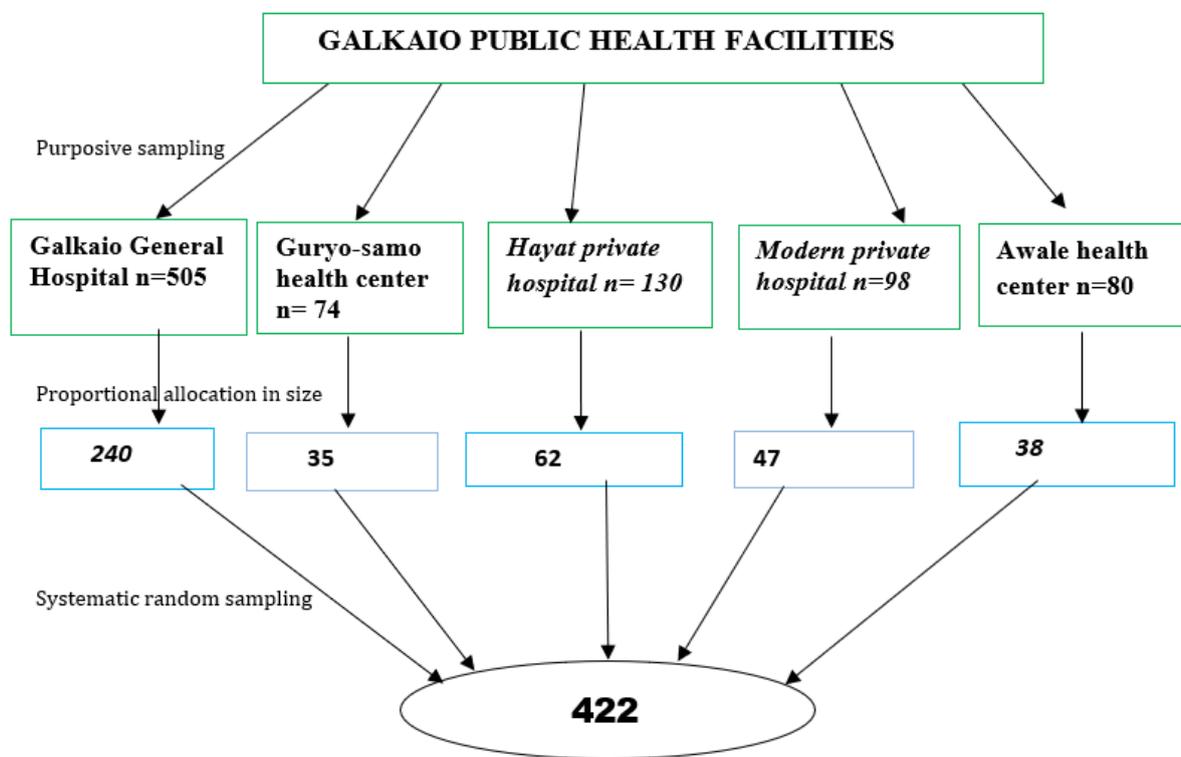

Figure 1: Diagram on the sampling procedure for the study on the magnitude of anemia and associated factors among Adult with tuberculosis in Galkaio Public Health Facilities 2024.

Data collection procedure

Two trained nurses and two laboratory technicians participated in the data collection. Data collectors were in charge of interviewing the patients, compiling the results consistently, and then delivering them on time to the investigator. Training was provided on interviewing techniques, questionnaire completion, anthropometric measurement, laboratory testing, and how to approach respondents.

Data collection instrument

The study subjects were interviewed using a structured questionnaire. The contents of the questionnaire include sociodemographic factors, dietary factors, behavioral factors, clinical characteristics, anthropometric characteristics, and laboratory results. used a face-to-face interview. A portable HemoCue hemoglobin was used. Capillary blood samples were collected by lancing the middle finger tip that had been cleaned with 70% alcohol beforehand. After the first two drops of blood had been removed with a dry swab, a third drop of blood was collected and put into a microcuvette.

Data quality control

To assure the quality of the data, a structured, pre-tested questionnaire was used. In order to assess the appropriateness of the wording, clarity of the questions, and respondent reaction to the questions and interviewer, it was pre-tested on 5% of the calculated sample size of patients who were not actual study participants, and adjustments were made based on the results of the pre-test. The data collectors and supervisors

had received two days of intensive training on the calibration of instruments, method of data collection, how to perform anthropometric measurements, Hgb measurements, translation of questionnaires to the local languages, purpose of the study, and ethical issues. The training was given by the principal investigator.

Data processing and analysis

The completeness and consistency of the data were checked before entering it into the computer, then the data was coded, double-entered into EPI Data 3.1, and exported into SPSS version 20 statistical software for analysis. Descriptive statistics were computed for many of the variables. Tables and graphs were used to depict frequencies and main findings. Binary logistic regression mode was used to see the possible relationships with the outcome variables. Covariates with a p-value less than 0.25 in the bivariate logistic regression analysis were entered into the multivariable logistic regression analysis to control potential confounders and identify factors associated with anemia. In multivariable analysis, a significant association of variables with the outcome was determined by using the adjusted odds ratio along with a 95% confidence interval. Variables with a p-value ≤0.05 were declared statistically significant. Model fitness was tested by the Hosmer-Lemeshow test of model fit (p-value > 0.05).

Ethical considerations

Ethical clearance was obtained from the Review Ethical Committee, School of Public Health, and Institute of Health Science of Jigjiga University. A formal letter was also obtained from the Jigjiga University School of Public Health and submitted to the Galkaio public health facilities. A clear description of the study title, purpose, procedure, and duration, as well as possible risks and benefits of the study, was explained for each study participant.

Additionally, the study participant was made fully aware of the study's objectives and asked to participate truthfully. Additionally, utilizing an anonymous questioner ensured the confidentiality of the data. Participants in the study were provided informed consent after being notified of the confidentiality of the information. Every participant was given the option to leave the study whenever they wanted.

RESULTS

Socio-demographic characteristics of study participants

Out of 422 study participants, 422 have participated in the study, giving a response rate of 100%. Regarding the age of participants, 33.4% were in the age group of 31–40 years, and more than half (61.6% of the study participants) were males. More than half of the participants, 31.5%, were unable to read or write, and 57.3% were urban residents. (Table 1).

Table 1: Socio-demographic characteristics of adult with tuberculosis in Galkaio Town public health facilities Puntland, Somalia 2024

Variables	Category	Frequency	Percentage (%)
Age	18-30	105	24.9
	31-40	141	33.4
	41-50	136	32.2
	51-60	40	9.5
Total		422	100.0%
Sex	Male	260	61.6
	Female	162	38.4
Total		422	100.0%
Residence	Rural	180	42.7
	Urban	242	57.3
Total		422	100.0%
Educational Level	Unable to read and write	133	31.5
	Able to read and write	124	29.4
	Only primary education	82	19.4
	Secondary education	37	8.8
	College diploma and above	46	10.9
Total		422	100.0%
Occupation	Government employee	29	6.9
	Student	89	21.1
	House wife	147	34.8
	Trader	39	9.2
	Other specify***	118	28.0
Total		422	100.0%

Other *** (Pastoralist= 33, Private =49, Soldier =21, Agro Pastoralist=15)

Dietary Characteristics

Table 2 below presents a comprehensive overview of dietary habits among the surveyed population. The majority of the respondents (298, or 70.6%) had consumed foods from both plant and animal sources, while a notable 29.4% identified as vegetarians. The majority of respondents (308) (73.0%) include animal-source foods in their diets, encompassing items such as meat, liver, eggs, poultry, and fish. Among those who do consume animal-source foods, varied frequencies are reported, with 126 (40.9%) opting for a weekly intake. Plant-source food consumption is widespread (306) (72.5%), with nearly half of the respondents (198) (46.9%) incorporating these foods into their daily meals. About 277 (65.6%) of respondents reported that they have a habit of drinking coffee or tea immediately after a meal, and 145 (34.4%) reported that they do not do so after a meal.

Table 2: Dietary Characteristics of adult with tuberculosis in Galkaio Town public health facilities Puntland, Somalia 2024

Variables	Category	Frequency	Percentage (%)
Dietary habit	Vegetarian	124	29.4
	Mixed	298	70.6
	Total	422	100%
Animal source food consumption (like meat, liver, egg, poultry and Fish)	Yes	308	73.0
	No	114	27.0
	Total	422	100%
Animal source food consumption frequency	Once a week	126	40.9
	Twice a week or more	102	33.1
	Every two-week	20	6.5
	Once a month	60	19.5
	Total	308	100%
Plant source foods consumption (like dark green leafy vegetables, legumes and whole Grains)	Yes	306	72.5
	No	116	27.5
	Total	422	100%
Plant source food consumption frequency	Everyday	198	46.9
	Every two day	155	36.7
	Every two week	50	11.8
	Once a month	19	4.5
	Total	422	100%
Drinking coffee or tea after meal	Yes	277	65.6
	No	145	34.4
	Total	422	100%

Behavioral Characteristics

Regarding behavioral factors, adults with tuberculosis in Galkaio Town public health facilities were asked about cigarette smoking and chewing. Concerning behavioral factors, 307 (72.7%) and 285 (67.5%) were found to have a history of smoking and chewing, respectively. (Figure 2).
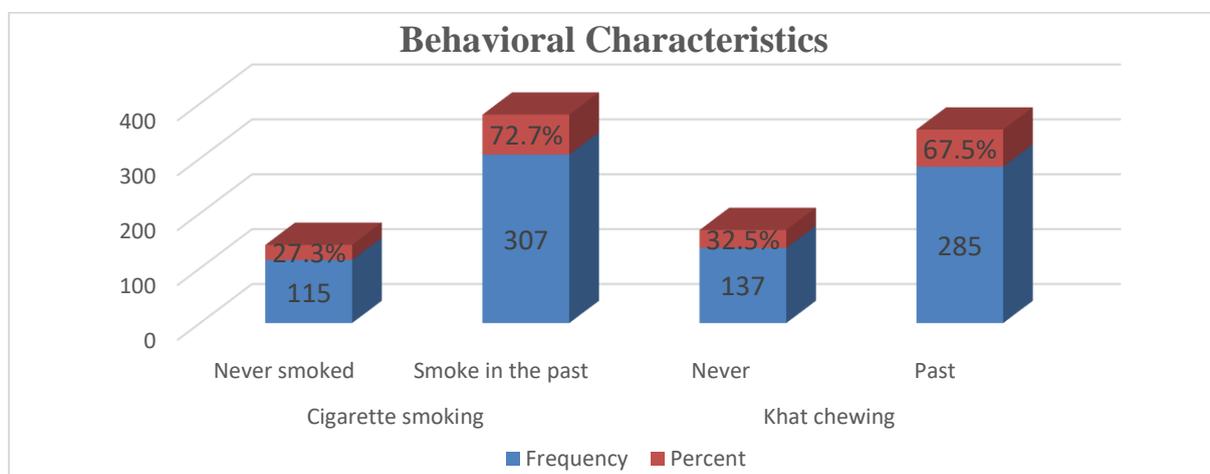

Figure 2: Behavioral characteristics of adult with tuberculosis in Galkaio Town public health facilities Puntland, Somalia 2024 (n=422).

Clinical Characteristics

Regarding the clinical characteristics, out of the 422 participants, 146 (34.6%) had a history of previous TB diagnosis, and generally, 307 (72.7%) were undertaking treatments against tuberculosis, whereas only 115 (27.3%) have not started it yet, but unfortunately, 301 (71.3%) individuals responded that they are not taking supportive therapy along with the anti-TB drug. Most patients reported experiencing weight loss (368; 87.2%), blood standing (335; 79.4%), cough (319; 75.6%), fever (26.6%), and night sweat (277; 65.6%). TB patients had coughing (86.1%) as their main complaint. Regarding the results of the anthropometric measurements, the majority (339, or 80.3%) of patients had a body mass index (BMI) less than 18.5 kg/m2. (Table 3).

Table 3: Clinical Characteristics of adult with tuberculosis in Galkaio Town public health facilities Puntland, Somalia 2024

Variables	Category		Frequency	Percentage (%)
TB Relapse	Yes		146	34.6
	No		276	65.4
Started taking treatment for TB	Yes		422	100
	No		0	0
Symptoms present	Yes		308	73.0
	No		114	27.0
Common signs and symptoms	Cough	Yes	319	75.6
		No	103	24.4
	Night sweat	Yes	277	65.6
		No	145	34.4
	Fever	Yes	281	66.6
		No	141	33.4
	Blood standing	Yes	335	79.4
		No	87	20.6
	Weight loss	Yes	368	87.2
		No	54	12.8
	Fatigue	Yes	282	66.8
		No	140	33.2
	Chest pain	Yes	209	49.5
		No	213	50.5
	Other**		7	1.8
Is there a symptom you complain the most	Yes		360	85.3
	No		62	14.7
Primary symptom complaint	Cough		310	86.1
	Night sweats		7	1.9
	Fever		16	4.4
	Weight loss		3	0.9
	Fatigue		9	2.5
	Chest pain		14	3.9
	Other***		1	0.3
Duration of the main complaints	< 1month		143	33.9
	≥ 1month		279	66.1
Giving anemia supportive agents	Yes		121	28.7
	No		301	71.3
Body mass index	Normal		83	19.7
	Underweight		339	80.3

Other** (Abdominal bloating=4, Loss of Appetite=3), Other ***(Abdominal bloating=1)

Magnitude of anemia among study participants

In this study, the magnitude of anemia among adults with tuberculosis and associated risk factors were studied. The majority of the respondents (349; 82.7%; CI: 78.09, 86.31) have anemic cases, with a higher prevalence among females (151; 93.2%) compared to males (198; 76.2%). Among the anemic adults with tuberculosis, the majority falls into the moderate Hb level category 146 (41.9%), followed by severe 94 (26.9%), mild 87 (24.9%), and a few respondents with life-threatening anemia (22.3%). (Figure 3).
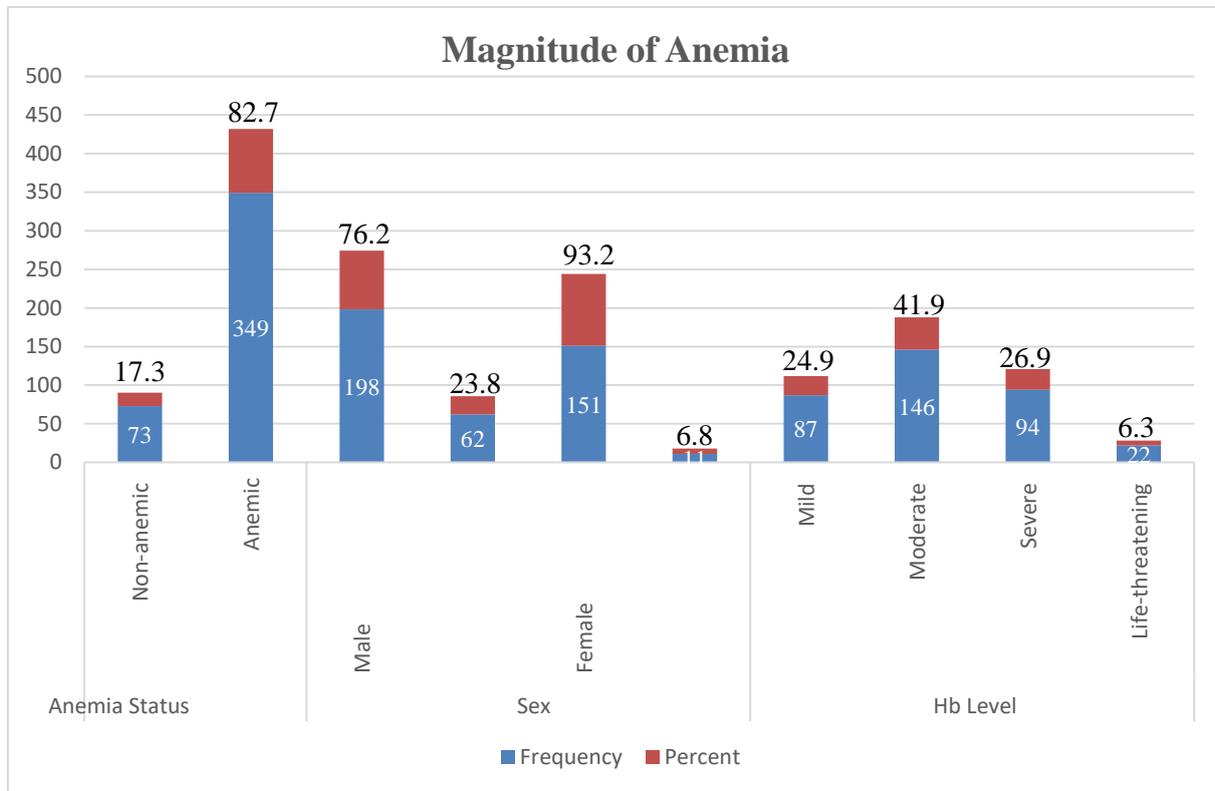

Figure 3: Magnitude of Anemia among adult with tuberculosis in Galkaio Town public health facilities Puntland, Somalia 2024.

Factors associated with Anemia among Adult with tuberculosis patients

To determine the association between dependent (anemia) and independent (explanatory) variables, bivariate and multivariate analyses were performed using binary logistic regression. Based on bivariable logistic regression analyses, age, sex, residence, educational level, occupation, dietary type, smoking, alcohol, khat chewing, previous TB episode diagnosis, started taking treatment for TB, duration of the main complaint (TB symptom), anemia supportive agents (support other than medication), and BMI were significantly associated (p<0.25) with anemia among TB patients (Table 4).

In multivariable logistic regression analyses, the odds of anemia were 4.23 times higher for patient age between 41 and 50 years [AOR = 4.23, 95% CI (1.92, 9.34)] as compared to age between 18 and 30 years; 3.07 times higher for patient age between 40 and 50 years [AOR = 3.07, 95% CI (1.84,5.15)] as compared to age between 18 and 30 years; and 2.8 times higher for patient age between 40 and 50 years [AOR = 2.8, 95% CI (1.11, 7.16)] as compared to age between 18 and 30 years.

The odds of anemia were 2.06 times higher for females as compared to males [AOR = 2.06, 95% CI: 1.02–4.16]. 3.25 times higher for patients who live in rural regions as compared to those who live in urban areas [AOR = 3.25, 95% CI (1.07, 8.01)], 6.12 times higher for patients unable to read and write as compared to those who had a college diploma and above [AOR = 6.12, 95% CI (2.63, 14.2)], and 5.64 times higher for patients able to read and write as compared to those who had a college diploma and above [AOR = 5.64, 95% CI (2.27, 17.7)]. Moreover, 2.53 times higher for patients having only primary education as compared to those who had a college diploma and above [AOR = 2.53, 95% CI (2.2, 10.20)], and 1.51 times higher for patients having secondary education as compared to those who had formal education [AOR = 1.51, 95% CI (1.7, 9.10)].

The odds of anemia were 2.34 times higher for pastoralists, private employees, soldiers, and agro-pastoralists compared to government employees [AOR=2.34, 95% CI (1.28, 6.3)]. The odds of anemia were also 2.15 times higher for housewives compared to government employees [AOR = 2.15, 95% CI (1.12, 9.10)]. Additionally, the odds of anemia were 2.52 times higher for patients who smoked in the past compared to those who never smoked [AOR=2.52, 95% CI (1.29, 4.93)]. Furthermore, the odds of anemia were 5.71 times higher for patients who had not started taking anti-TB drugs compared to those who had started [AOR=5.71, 95% CI (2.68, 12.14)]. The odds of anemia were also 2.74 times higher for TB relapse patients compared to those with no history of TB treatment [AOR=2.74, 95% CI (1.56, 4.95)]. The odds of anemia were also 2.28 times higher for undernourished patients compared to the normal group [AOR=2.28, 95% CI (1.09, 4.78)]. Moreover, the odds of anemia were 3.91 times higher for patients complaining of TB symptoms for ≥1 month compared to those with a recent complaint (<1 month) [AOR=3.91, 95% CI (1.15, 7.27)]. Lastly, the odds of anemia were 2.03 times higher for patients without anemia supportive agents (support other than medication) compared to those with anemia supportive agents [AOR=2.03, 95% CI (1.03, 4.01)]. (Table 5).

Table 4: Factors associated with Anemia among adult with tuberculosis in Galkaio Town public health facilities Puntland, Somalia 2024

Variables	Category	Anemia		COR	AOR
		Yes	No	(95%CI)	(95% CI)
Age	18-30	59(56.2 %)	46(43.8%)	[Ref]	[Ref]
	31-40	126(89.4%)	15(10.6%)	3.5(1.96, 6.30)*	2.8 (1.11, 7.16)**
	41-50	133(97.8)	3(2.2%)	3.74 (2.05,6.84)*	4.23 (1.92,9.34)**
	51-60	31(77.5%)	9(22.5%)	2.15 (1.84,5.14) *	3.07 (1.84,5.15) **
Sex	Male	198(76.2%)	62(23.8%)	[Ref]	[Ref]
	Female	151(93.2%)	11(6.8%)	3.97(2.32, 6.8)*	2.06 (1.02,4.16)*
Residence	Rural	235(97.1%)	7(2.9%)	4.05(1.73, 9.49)*	3.25 (1.07, 8.01)**
	Urban	114(63.3%)	66(36.7%)	[Ref]	[Ref]
Educational Level	Unable to read and write	129 (97%)	4(3%)	9.07(5.7,12.1) *	6.12(2.63,14.2)**
	Able to read and write	117(94.4%)	7(5.6%)	11.23(5.1,29.4)*	5.64(2.27,17.7)**
	Only primary education	70(85.4%)	12(14.6%)	6.01(3.2,11.5) *	2.53(2.2,10.20)*
	Secondary education	26(70.3%)	11(29.7%)	7.37(3.7,14.7) *	1. 51(1.7,9.10)*
	College diploma and above	7(15.2%)	39(84.8%)	[Ref]	[Ref]
Occupation	Government employee	4(13.8%)	25(86.2%)	[Ref]	[Ref]
	Student	57(64%)	32(36%)	2.72(1.69,4.37)*	1.8 (0.57,3.46)
	House wife	145(98.6%)	2(1.4%)	5.94(1.91,18.52)*	2.15(1.12,9.10)*
	Trader	26(66.7%)	13(33.3%)	4.53(2.72,7.63)*	1.7 (0.59, 4.72)
	Other ***	117(99.2%)	1(0.8%)	4.45(2.15,19.34)*	2.34 (1.28, 6.3)*
Cigarette smoking	Never smoked	64(55.7%)	51(44.3%)	[Ref]	[Ref]
	Smoke in the past	285(92.8%)	22(7.2%)	2.22 (1.34,3.66)*	2.52 (1.29,4.93)**
Khat chewing	Never	74(54%)	63(46%)	[Ref]	[Ref]
	Past	275(96.5%)	10(3.5%)	4.35(2.07,9.2) *	1.9(0.95,5.63)
Dietary habit	Vegetarian	118(95.2%)	6(4.8%)	4.53(1.24,16.57)*	1.18(0.15,9.85)
	Mixed	231(77.5%)	67(22.5%)	[Ref]	[Ref]
TB Relapse	Yes	143(98%)	3(2%)	2.81 (1.88,4.18)*	2.74 (1.56,4.95) *
	No	206(74.6%)	70 (25.4%)	[Ref]	[Ref]
Started taking Anti-TB drugs	Yes	236(76.9%)	71(23.1%)	[Ref]	[Ref]
	No	113(98.3%)	2(1.7%)	14.9(8.6,25.9)*	5.71(2.68,12.14)**
Duration of the main complaints	< 1month	96(67.1%)	47(32.9%)	[Ref]	[Ref]
	≥ 1month	253(90.7%)	26(9.3%)	6.44(2.29,18.14)*	3.91(1.151,7.27)**
Anemia supportive agents (support other than medication)	Yes	62(51.2%)	59(48.8)	[Ref]	[Ref]
	No	287(95.3%)	14(4.7%)	2.76 (1.51, 5.05)*	2.03 (1.03, 4.01)*
Body mass index	Normal	23(27.7%)	60(72.3%)	[Ref]	[Ref]
	Underweight	326(96.2%)	13(3.8%)	6.66(3.9,11.38)*	2.28(1.09, 4.78) *

Other *** (Pastoralist= 33, Private =49, Soldier =21, Agro Pastoralist=15)

NOTE: *Significant at p < 0.05, **=p<0.001, COR =Crude Odds Ration, AOR= Adjusted Odds Ratio, CI= Confident Interval, [Ref] = Reference.

DISCUSSION

This study evaluated the magnitude and factors associated with anemia among people with TB in Galkaio Town public health facilities in Puntland, Somalia, in 2024, with a sample size of 422. According to the findings of the study, 82.7% (CI: 79.09–86.31%) of people with TB had anemia, with a higher prevalence among females (93.2%) compared to males (76.2%). Among the anemic adults with tuberculosis, the majority falls into the moderate Hb level category (41.9%), followed by severe 26.9%, mild 24.9%, and a few respondents with life-threatening anemia (6.3%). The finding was much closer to a study done in India 72.6% [15]. The magnitude of anemia was lower when compared to studies conducted in Brazil 89.2% [24] and Tanzania 86% [17]. On the other hand, other studies found prevalence lower than this study such as, study conducted in Uganda 58.7% [25]. In Ethiopia 69%[26] and Sudan 44%[6]. Meanwhile a study conducted in India found a greater magnitude discovered 96%[27]. Also study conducted India was finding 100% [28]. Over all, the difference in magnitude of anemia may be explained by differences in the socio-economic status, study time difference, study area, the health intervention measurement taken, and the sample size of the study.

In our multivariable logistic regression analysis, several factors emerged as significant predictors of anemia among tuberculosis patients. Age: Our findings indicate that patients aged 41–50 years are 4.23 times more likely to develop anemia compared to those aged 18–30 years. This may be due to the natural decline in hemoglobin levels with aging, as well as increased inflammation and oxidative stress. Gender: Females are 2.06 times more likely to develop anemia than males, which may be attributed to menstrual blood loss, pregnancy, and hormonal factors. Residence: Patients from rural areas face a significantly higher risk of anemia (3.25 times) compared to their urban counterparts. This could be due to limited access to healthcare, nutritional deficiencies, and environmental factors.

Education: our analysis reveals that patients with no formal education are at a substantially higher risk of anemia (6.12 times) compared to those with formal education. This may be linked to lower health literacy, limited access to healthcare, and poorer socioeconomic status. Occupation: Certain occupational categories (pastoralist, private worker, soldier, and agro-pastoralist) are associated with a 2.34 times higher risk of anemia compared to government employees. This could be due to varying levels of physical activity, exposure to environmental toxins, and access to healthcare.

Smoking: Former smokers face a 2.52 times higher risk of anemia compared to non-smokers, possibly due to the lingering effects of smoking on hemoglobin levels and inflammation. Anti-TB treatment: Patients who have not initiated anti-TB drugs face a significantly higher risk of anemia (5.71 times) compared to those who have commenced treatment. This highlights the importance of timely treatment initiation in managing anemia risk. TB relapse_: Patients with a history of TB relapse are 2.74 times more likely to develop anemia compared to those without prior TB treatment history, possibly due to the cumulative effects of repeated infections and treatment on hematopoiesis. Nutritional status: Undernourished individuals face a 2.28 times higher risk of anemia compared to those with normal nutritional status, likely due to inadequate iron and nutrient intake.

Anemia is a common association with TB and this anemia most of the time partially responded with anti-TB medication (95%). This study clearly showed that anemia is usually associated with TB cases in our region. The majority of TB patients were unemployed, which were more common among female. This result is supported by a finding from a studies conducted in Sri lank [29].

This study revealed that being female was strongly associated with Anemia. This finding is in accordance with the study conducted in Isfahan Iran [28], China [28]globally and also with study conducted in University of Gondar Ethiopia [28]study conducted in Tukir Ambessa specialized referral hospital Addis Abeba Ethiopia and with study conducted in Dere Dawa East Ethiopia [28]This may be due in part to the fact that, in general, anemia is more prevalent in women than men. Menses, pregnancy and lactation are times when women are more at risk for anemia; during menses the loss of iron in menstrual blood ranges from 12.5 to 15.0 mg per month [28]and also men are capable of storing greater amounts of iron, approximately 1000 mg of iron, whereas women are able to store only 300 to 500 mg [28].

The present study shows that, most of the TB patients, were malnourished (BMI<18.5) Also study done in Bangladesh was much closer our result [7]. While those with normal weight were less likely to be anemic. This finding is consistent with previous studies conducted in developing countries [7]. This may be because the underweight individuals are less aware about the benefit of appropriate nutrition consumption and/or have a less socioeconomic and educational condition or may have less adherence to TB drug therapy [7]. Further. On the other hand, old age were risk factors for TB-associated anemia in our data. The prevalence of anemia usually increases with age between 40-50 years The increasing prevalence of anemia with age has been explained by increased chronic disease, poor nutritional status, decreased marrow cellularity _ and low serum vitamin B$_{12}$ levels In this context, old age could be interpreted as a risk factor for TB-associated anemia as a study conducted in Korea[13].

CONCLUSION

The study reveals a significant burden of anemia among tuberculosis patients in Galkio Town Public Health. An alarming 82.7% of the patients were anemic, with varying degrees of severity. This underscores the importance of addressing anemia as a critical aspect of TB care. Regarding the risk factors associated with anemia, this study demonstrated significant associations between anemia and various factors through bivariable logistic regression analyses. Age, sex, residence, educational level, occupation, dietary type, smoking, alcohol, khat chewing, previous TB episode diagnosis, starting treatment for TB, duration of the main complaint (TB symptom), and anemia-supportive agents (other than medication) are predictors of anemia among adult TB patients.

Recommendations

Based on the study findings, the following recommendations are forwarded to mitigate the adverse effects of anemia in TB patients, recognizing that reducing the magnitude of anemia will improve survival and quality of life.

Patient-level recommendations:

Adhere to anti-TB treatment and supportive therapy as prescribed by your healthcare provider.

Eat a balanced diet rich in iron, vitamins, and minerals to combat anemia.

Avoid smoking and limit exposure to secondhand smoke.

Complete the full course of anti-TB drugs and attend follow-up appointments.

Family-level recommendations:

Support your family member with TB by encouraging them to adhere to treatment and attend follow-up appointments.

Help prepare nutritious meals and snacks to combat anemia.

Encourage family members to quit smoking or avoid smoking around the patient.

Provide emotional support and reduce stress to help manage TB symptoms.

Community-level recommendations:

Organize community-based health education programs to raise awareness about TB, anemia, and nutrition.

Encourage community members to support TB patients and their families.

Promote access to nutritious food and clean water.

Encourage community members to quit smoking and reduce exposure to secondhand smoke.

Health care providers

Nutritional Support: Given that a substantial percentage of patients had an underweight Body Mass Index (BMI), it is recommended to implement nutritional support programs for tuberculosis patients. These programs should focus on improving their dietary intake to combat appetite loss, which is common among TB patients.

Puntland state public health facilities

Supportive Therapy: Encourage healthcare providers to ensure that patients receive supportive therapy in addition to anti-TB treatment. Supportive therapy can help manage anemia and improve overall health outcomes.

For researchers

Further investigation is needed into the particular types and alternative factors contributing to anemia have the potential for inspiring more targeted clinical interventions for specific patient groups. This, in turn, could lead to significant enhancements in their overall well-being and chances of survival.

Authors contribution

Every author has significantly contributed to the concept, method of study, data collection, analysis, and interpretation of the study; they also contributed to the manuscript's development, critically reviewed it, and decided which publication the paper should be submitted to. All authors read and agreed to the final version of the manuscript, and they agreed to be responsible for all contents of the manuscript.

Acknowledgment

Conflict of interest

The authors sustain no conflict of interest.

Funding

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

References

1. Chaparro CM and Suchdev PS. Anemia epidemiology, pathophysiology, and etiology in low-and middle-income countries. Annals of the new York Academy of Sciences. 2019; 1450: 15-31. https://doi.org/10.1111/nyas.14092 PMid:31008520 PMCid:PMC6697587

2. Nienaber A, Baumgartner J, Dolman RC, et al. Omega-3 fatty acid and iron supplementation alone, but not in combination, lower inflammation and anemia of infection in mycobacterium tuberculosis-infected mice. Nutrients. 2020; 12: 2897. https://doi.org/10.3390/nu12092897 PMid:32971969 PMCid:PMC7551947

3. Gil-Santana L, Cruz LA, Arriaga MB, et al. Tuberculosis-associated anemia is linked to a distinct inflammatory profile that persists after initiation of antitubercular therapy. Scientific reports. 2019; 9: 1-8. https://doi.org/10.1038/s41598-018-37860-5 PMid:30718725 PMCid:PMC6361962

4. Yaranal PJ, Umashankar T and Harish SG. Hematological profile in pulmonary tuberculosis. Int J Health Rehabil Sci. 2013; 2: 50-5.

5. Hungund B, Sangolli S, Bannur H, et al. Blood and bone marrow findings in tuberculosis in adults-A cross sectional study. Al Ameen J Med Sci. 2012; 5: 362-6.

6. Bashir BA, Abdallah SA and Mohamedani AA. Anemia among patients with pulmonary tuberculosis in Port Sudan, Eastern Sudan. Int J Recent Sci Res. 2015; 6: 4128-31.

7. Monjur F and Rizwan F. A cross-sectional study of morphological types of anemia in pulmonary tuberculosis patient and associated risk indicators in a selected hospital of Dhaka city, Bangladesh. Bangladesh I JChem Environ Biol Sci. 2014; 4: 215-9.

8. Adzani M, Dalimoenthe NZ and Wijaya I. Profile of Anemia on Lung Tuberculosis at Dr. Hasan Sadikin General Hospital and Community Lung Health Center Bandung. Althea Medical Journal. 2016; 3: 137-40.

9. Anurag L and Richa C. Cold agglutinin induced hemolytic anemia in a patient with pulmonary tuberculosis. International Journal of Medical Research & Health Sciences. 2015; 4: 911-2. https://doi.org/10.5958/2319-5886.2015.00184.8

10. Metanat M, Mashhadi MA, Alavi-Naini R, Rezaie-Kahkhaie L, Sepehri-Rad N and Afshari M. The Prevalence of Absolute and Functional Iron Deficiency Anemia in New Cases of Smear-positive Pulmonary Tuberculosis and Their Sputum Conversion Rate at the End of Intensive Tuberculosis Treatment Phase. Prague medical report. 2020; 121: 35-41. https://doi.org/10.14712/23362936.2020.3 PMid:32191618

11. Gelaw Y, Getaneh Z and Melku M. Anemia as a risk factor for tuberculosis: a systematic review and meta-analysis. Environmental Health and Preventive Medicine. 2021; 26: 1-15. https://doi.org/10.1186/s12199-020-00931-z PMid:33485299 PMCid:PMC7824931

12. Isanaka S, Mugusi F, Urassa W, et al. Iron deficiency and anemia predict mortality in patients with tuberculosis. The Journal of nutrition. 2012; 142: 350-7. https://doi.org/10.3945/jn.111.144287 PMid:22190024 PMCid:PMC3260062

13. Lee SW, Kang YA, Yoon YS, et al. The prevalence and evolution of anemia associated with tuberculosis. Journal of Korean medical science. 2006; 21: 1028-32. https://doi.org/10.3346/jkms.2006.21.6.1028 PMid:17179681 PMCid:PMC2721923

14. Olaniyi J and Aken'Ova Y. Haematological profile of patients with pulmonary tuberculosis in Ibadan, Nigeria. African Journal of Medicine and Medical Sciences. 2003; 32: 239-42.

15. Barzegari S, Afshari M, Movahednia M and Moosazadeh M. Prevalence of anemia among patients with tuberculosis: A systematic review and meta-analysis. Indian Journal of Tuberculosis. 2019; 66: 299-307. https://doi.org/10.1016/j.ijtb.2019.04.002 PMid:31151500

16. Minchella PA, Donkor S, Owolabi O, Sutherland JS and McDermid JM. Complex anemia in tuberculosis: the need to consider causes and timing when designing interventions. Clinical Infectious Diseases. 2015; 60: 764-72. https://doi.org/10.1093/cid/ciu945 PMid:25428413

17. Nagu TJ, Spiegelman D, Hertzmark E, et al. Anemia at the initiation of tuberculosis therapy is associated with delayed sputum conversion among pulmonary tuberculosis patients in Dar-es-Salaam, Tanzania. PloS one. 2014; 9: e91229. https://doi.org/10.1371/journal.pone.0091229 PMid:24642636 PMCid:PMC3958362

18. de Mendonca EB, Schmaltz CA, Sant'Anna FM, et al. Anemia in tuberculosis cases: A biomarker of severity? Plos one. 2021; 16: e0245458. https://doi.org/10.1371/journal.pone.0245458 PMid:33529195 PMCid:PMC7853529

19. Krapp F, Veliz J, Cornejo E, Gotuzzo E and Seas C. Bodyweight gain to predict treatment outcome in patients with pulmonary tuberculosis in Peru. The international journal of tuberculosis and lung disease. 2008; 12: 1153-9.

20. Magzoub M. Hematological Changes Among Tuberculous Sudanese patients in Kassala Area Eastern Sudan Mubarak I Idriss, Hiba B Khalil 2, Abbashar O Abbashar 3, Sara Widaah 3 &. 2013.

21. Zhang S-Y, Fu J-Y, Guo X-Y, et al. Improvement cues of lesion absorption using the adjuvant therapy of traditional Chinese medicine Qinbudan tablet for retreatment pulmonary tuberculosis with standard anti-tuberculosis regimen. Infectious Diseases of Poverty. 2020; 9: 1-11. https://doi.org/10.1186/s40249-020-00660-z PMid:32381098 PMCid:PMC7203794

22. Sahiratmadja E, Wieringa FT, van Crevel R, et al. Iron deficiency and NRAMP1 polymorphisms (INT4, D543N and 3′ UTR) do not contribute to severity of anaemia in tuberculosis in the Indonesian population. British Journal of Nutrition. 2007; 98: 684-90. https://doi.org/10.1017/S0007114507742691 PMid:17466092

23. Atomsa D, Abebe G and Sewunet T. Immunological markers and hematological parameters among newly diagnosed tuberculosis patients at Jimma University Specialized Hospital. Ethiopian journal of health sciences. 2014; 24: 311-8. https://doi.org/10.4314/ejhs.v24i4.6 PMid:25489195 PMCid:PMC4248030

24. Oliveira MG, Delogo KN, Oliveira HMdMGd, Ruffino-Netto A, Kritski AL and Oliveira MM. Anemia in hospitalized patients with pulmonary tuberculosis. Jornal Brasileiro de Pneumologia. 2014; 40: 403-10. https://doi.org/10.1590/S1806-37132014000400008 PMid:25210963 PMCid:PMC4201171

25. Baluku JB, Mayinja E, Mugabe P, Ntabadde K, Olum R and Bongomin F. Prevalence of anaemia and associated factors among people with pulmonary tuberculosis in Uganda. Epidemiology & Infection. 2022; 150. https://doi.org/10.1017/S0950268822000103 PMid:35022106 PMCid:PMC8888272

26. Abaynew Y, Ali A, Taye G and Shenkut M. Prevalence and types of anemia among people with tuberculosis in Africa: a systematic review and meta-analysis. Scientific Reports. 2023; 13: 5385. https://doi.org/10.1038/s41598-023-32609-1 PMid:37012387 PMCid:PMC10070325

27. Hungund BR, Sangolli SS, Bannur HB, et al. Blood and bone marrow findings in tuberculosis in adults -A cross sectional study. 2012.

28. Mishra S, Taparia MP, Yadav D and Koolwal S. Study of iron metabolism in pulmonary tuberculosis patients. Int J Health Sci Res. 2018; 8: 70-7.

29. Umakanth M. Anemia among tuberculosis patient in teaching hospital Batticaloa, Sri Lanka. Int J Med Heal Res. 2017; 3: 95-7.