

Prevalence and Characteristics of Anemia Among Tuberculosis Patients at Wad Medani Teaching Hospital, Gezira State, Sudan (2025)

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Abstract

Background: Tuberculosis (TB) remains one of the most prevalent and serious infectious diseases worldwide, particularly in Sudan, where it contributes significantly to morbidity and mortality. Anemia is a common complication of TB infection, further exacerbating disease severity and negatively impacting patient outcomes.

Aim: The study aimed to determine the frequency of anemia among TB-infected patients and to assess the influence of various factors including gender, age group, type of TB infection, and treatment status.

Methods: Cross-sectional study, conducted in March 2023 at Wad Medani Teaching Hospital, Gezira State, Sudan among 250 confirmed TB patients. Hematological parameters measured using Sysmex XP-300.

Results: 250 TB patients participated in the study, comprising 167 males (66.8%) and 83 females (33.2%). 224 patients (89.6%) with pulmonary TB, while 26 (10.4%) had extrapulmonary TB. Among the participants, 150 (60%) were receiving anti-TB treatment, and 100 (40%) were untreated. Frequency of anemia was 13.6% [22 (64.7%) had moderate anemia and 12 (35.3%) had mild anemia]. Normocytic anemia was observed in 17 patients (50%), while 13 (38.2%) presented with microcytic hypochromic anemia.

Conclusion: Anemia observed among 13.6% TB patients particularly 19-40 years age group. Routine complete blood count recommended for early detection of anemia in TB patients.

Keywords: Tuberculosis, Anemia, Hematological parameters, Sudan

Introduction

Tuberculosis is one of the most common diseases worldwide, with high morbidity and mortality rates, particularly in Sudan and other developing countries [1]. TB infection transmits via inhalation of droplet nuclei containing viable tubercle bacilli. TB predominantly affects young adults in their most productive years of life and has substantial impact on economic development [2]. Mycobacterium tuberculosis is carried in airborne particles, called droplet nuclei, of 1-5 microns in diameter. Infectious droplet nuclei are generated when persons who have pulmonary or laryngeal TB disease cough, sneeze, shout, or sing. Infection occurs when a person inhales droplet nuclei containing tubercle bacilli that reach the alveoli of the lungs. These tubercle bacilli are ingested by alveolar macrophages [3]. When phagocyte get to be functional, they recruit other immune cell cells, like granulocyte, which are

crucial early encounters in tuberculosis infection, putting on an act in pathogen eradication and also inflammatory process [4]. Tuberculosis leads to diverse symptoms and signs according to infected organs. The lungs are involved in approximately 90% of cases, while the gastrointestinal tract, genitourinary tract, lymph nodes, bone, muscle, and central nervous system can also be involved in so-called extra pulmonary tuberculosis [5]. Laboratory diagnosis of tuberculosis include culture of M. TB in a suitable medium which remains the gold standard diagnostic test. Culture in solid or liquid media, direct microscopy is a fast and inexpensive method to identify acid fast bacilli (AFB) traditionally Ziehl-Neelsen (ZN) stain applied and the sample termed smear positive or smear negative dependent on the present or absent of bacilli, molecular test (e.g., Xpert or Truenat) is also recommended by WHO [6]. Treatment of tuberculosis include rifampicin, isoniazid, pyrazinamide and other (e.g. RIF +ETM +FLQ) for six month [6]. Because VTE can be fatal, it is crucial to suspect it to perform early diagnosis and initiate prompt treatment [7].

Anemia is classified morphologically into microcytic, normocytic, and macrocytic types based on red blood cell size. It can also be categorized etiologically into decreased production, increased destruction (hemolysis), or blood loss. Pathophysiological classification focuses on mechanisms such as impaired erythropoiesis or reduced red cell survival [8].

Anemia commonly complicates infections like Tuberculosis, malaria, and HIV. It results from inflammation, iron sequestration, bone marrow suppression, and reduced erythropoietin response. This leads to anemia of chronic disease, worsening patient outcomes and delaying recovery [9].

Anemia is one of the most common hematological problems occur among patients with tuberculosis. Anemia is associated with a fourfold risk for TB infection. TB associated anemia has multiple cause including suppression of erythrocyte by inflammatory markers as well as nutritional causes. The high prevalence of anemia in TB patients is concerning because of its association with delayed sputum conversion. Severe form of TB such as meningitis and disseminated disease. TB related morbidity and TB recurrence. it therefor imperative to screen for anemia among people with TB infection [10].

However, the prevalence of Anemia among Tuberculosis (TB) patients in Sudan remains inadequately characterized. This study was conducted to assess the frequency of anemia and delineate hematological patterns in TB patients attending Wad Medani Teaching Hospital, in order to support evidence-based screening and clinical management strategies.

Methodology

This cross-sectional study was conducted in March 2023 at Wad Medani Teaching Hospital, Gezira State, Sudan. A total of 250 patients with confirmed Tuberculosis (TB) were recruited from the TB clinic using simple random sampling. Inclusion criteria comprised Sudanese patients with a confirmed TB diagnosis, while patients with hereditary anemia, pregnancy, HIV infection, alcoholism, or incomplete diagnostic data were excluded.

Data were collected using a structured questionnaire and laboratory investigations. Complete blood count (CBC) was performed using the Sysmex XP-300 analyzer. Anemia was defined according to WHO criteria (hemoglobin <13 g/dL for men and <12 g/dL for women) and classified as mild (11–11.9 g/dL), moderate (8–10.9 g/dL), or severe (<8 g/dL) [8,9]. Reticulocyte count was assessed using new methylene blue staining under oil immersion, erythrocyte sedimentation rate (ESR) by the Westergren method, and peripheral blood smear using Leishman stain. A total of 3 mL of venous blood was collected in EDTA tubes.

Statistical analysis was performed using SPSS version 22. Descriptive statistics were presented as means ± standard deviation and frequencies, while associations were evaluated using the chi-square test, with p-values <0.05 considered statistically significant. Ethical approval was obtained from the Gezira State Ministry of Health Ethics Committee.

Results

Among 250 TB infected patients 66.8% were male and 33.2% were female. 55.6% of patients aged between 19-40 years. 89.6% have pulmonary TB (Table 1).

Table 1: Demographic and Professional Characteristics of Participants (n = 250)

Variable	Category	N (approx)	%
Gender	Male	167	66.8
	Female	83	33.2
Age groups	< 20 years	72	28.8
	20 – 40 years	139	55.6
	> 40 years	39	15.6
Types of TB	Pulmonary TB	224	89.6
	Extra-pulmonary TB	26	10.4
Treatment status	Yes	150	60
	No	100	40

Table 2: RBCs Parameters, Reticulocyte count and ESR

Parameters	Minimum	Maximum	Mean	Std. Deviation
RBCs count X 10 ⁹	2.7	17.0	5.2	1.4
Hb g/dl	7.2	18.4	13.3	2.3
PCV%	25.0	34	55.7	15.0
MCV fl	20.0	130.0	87.3	14.6
MCH pg	16.2	35.3	23.6	3.1
MCHC g/dl	18.0	42.6	28.3	5.2
RDW-CV%	12.0	39.0	17.7	4.0
RDW-SD fl	19.0	96.0	60.6	13.4
ESR	5	80	23.5	17.1
Retic%	1	3	2	

35 (14%) of TB patients were anemic and 215 (86%) were not anemic (figure 1).

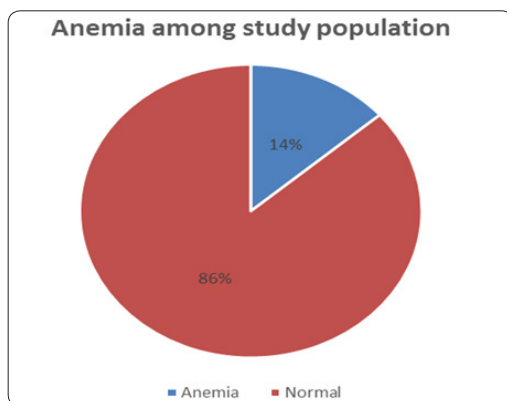


Figure 1: Distribution of anemia among study population

Among anemic patients 55.8% were male. 82.4% with pulmonary tuberculosis. 50% showed normocytic normochromic RBCs, 38.2% were microcytic hypochromic RBCs, and 11.8% macrocytic RBCs. 35.3% with mild anemia and 22 64.7% with moderate anemia.

Table 3: Frequency of anemia with different factors.

Variable	Category	Frequency	Percent
Gender	Male	19	55.8
	Female	15	44.2
Age groups	< 20 years	12	35.3
	20 – 40 years	18	52.9
	> 40 years	4	11.8
Types of TB	Pulmonary TB	28	82.4
	Extra-pulmonary TB	6	17.6
Treatment status	Yes	15	44.1
	No	19	55.9
Morphological types of anemia	Normocytic normochromic	17	50
	Microcytic hypochromic	13	38.2
	Macrocytic	4	11.8
Clinical types of anemia	Moderate	22	64.7
	Mild	12	35.3
Retic count	Normal	33	97.1
	Abnormal	1	2.9

Discussion

This study provides a critical interpretation of the study findings on anemia among tuberculosis-infected individuals attending Wad Medani Teaching Hospital. The results are discussed in relation to existing literature, highlighting similarities, discrepancies, and possible explanatory factors. Emphasis is placed on the clinical significance of hematological patterns, the influence of demographic and treatment-related variables, and the broader implications for TB management and patient care in similar settings. TB is one of the causes of anemia in chronic disease. most pulmonary TB patients experience anemia (74% with normocytic normochromic and 26% with microcytic hypochromic anemia) which can directly impact TB associated morbidity [11]. The type of anemia, morphological description of erythrocyte and RBCs inclusion in TB patients can provide assistance and even gives certain diagnosis information in assessing and treatment of anemia accordingly decrease the severity of disease.

This is a cross-sectional study conducted from February to April 2023. The aim of study was to assess anemia among tuberculosis infected patients attending Wad Medani Teaching Hospital, Gezira State, Sudan. Among of 250 TB patients participated in this study, there was a clear male predominance with 167 males (66.8%) and

83 females (33.2%) agree with international studies indicating that males have an increased TB risk due to their behavioral and occupational factors [12,13].

Regarding treatment status, 150 (60%) of patients were undergoing anti-tubercular therapy and 100 (40%) had not yet started treatment. These proportions align closely with the treatment rates reported by Bates et al., [14]. Though minor differences could be attributed to healthcare access and awareness levels. In this study the hematological profiles of tuberculosis (TB) patients were assessed, with a focus on red blood cell indices and anemia characterization. The findings reflect a generally preserved hematologic status among the TB patients. When compared to previous studies, significant differences were noted, especially in hemoglobin levels and red cell indices [15]. These differences suggest more severe anemia due to many factors such as advanced disease stage, pre-treatment status, or nutritional deficiencies in those populations [16-18]. In contrast this study presents with higher Hb levels and RBC indices, indicating a relatively lower prevalence and severity of anemia. These discrepancies may come mainly from earlier diagnosis, better nutritional support, and higher rates of anti-tubercular therapy. In this study mean MCV of 87.3 fL aligns with normocytic patterns observed in previous

studies although the study values were higher, reflecting less significant shifts to microcytic or macrocytic [17,19].

RDW-CV in this study was 17.7% agree with values reported by Singh et al., and Mukherjee et al., both of whom observed elevated RDW as a marker of anisocytosis, and this suggests size variability of RBCs is a common hematologic feature in TB, even in patients with near normal Hb levels [18,19]. Furthermore, while studies such as Mukherjee et al., and Fernandes et al., in reported significantly reduced PCV, MCHC, and RBC counts, this study findings showed elevated RBC count (5.2 million/mm³) and PCV (55.7%), which may again indicate better health status, more enhanced erythropoiesis [19,20]. Red blood cell morphology was normal in 196 patients (78.4%), while 38 (15%) had microcytic hypochromic, and 16 (6.4%) had macrocytic features. This distribution is highly comparable to findings by Shafee et al., and Lee et al., supporting the association between TB and both iron deficiency anemia and anemia of chronic disease. The proportion of microcytic hypochromic RBCs can vary depending on the nutritional status of the studied population and the overall duration of disease, while lower rates of macrocytic anemia may be due to differences in local prevalence of nutritional deficiencies such as vitamin B12 and folate [21,22]. This study observed a notably low anemia prevalence of 13.6% among TB patients, with 64.7% moderate and 35.3% mild anemia. This contrasts sharply with higher frequency reported by Mukherjee et al., (60%), Patel et al., (88%), Dasaradhan et al., (over 67%), Kumar et al., (48%), and Singh et al., (65%), reflecting earlier diagnosis, better treatment access, and improved nutrition in this study population [15-19]. Morphologically, 50% of anemic patients showed normocytic anemia and 38.2% microcytic hypochromic anemia, agreeing with prior studies where normocytic normochromic anemia predominates due to inflammation associated erythropoietic suppression [17, 19]. The lower macrocytic anemia found here compared to Mukherjee et al., (12.1% macrocytic) may suggest fewer vitamin B12/folate deficiencies [19]. Gender differences were not significant (P=0.218), consistent with Mukherjee et al., and others showing no strong sex association with TB related anemia [19]. Age was significantly associated with anemia (P=0.004), with younger patients (<19 years) more affected, matching the results in pediatric cohorts Li et al., but differing from Mukherjee et al., possibly due to differing sample structures. While anemia was more frequent in patients with extra-pulmonary TB (23%) compared to pulmonary TB (13%) this difference was not statistically significant (P=0.406), a finding aligning with variability across studies where severe or disseminated TB tends to correlate with more anemia but small subgroup sizes may limit significance [19-22]. Anemia prevalence was higher in untreated patients (19%) than treated patients (10%), consistent with evidence that anti-TB therapy alleviates anemia by reducing inflammation, though the association was not statistically significant here (P=0.610).

In summary, this study found that anemia among tuberculosis patients was predominantly mild to moderate, with a lower prevalence and severity than reported in much of the existing literature. Most anemic cases were normocytic normochromic, aligning with the typical pattern seen in TB-related anemia. Compared to previous studies, the higher hemoglobin levels and better-preserved red cell indices observed here suggest that factors such as improved nutrition, timely diagnosis, effective treatment, and strong patient management may contribute to more favorable hematologic profiles. These results highlight the importance of early intervention and comprehensive care in mitigating the severity of anemia in TB patients. Routine hematologic monitoring should continue to play a key role in TB case management to ensure optimal patient outcomes.

Conclusion

The Frequency of anemia among tuberculosis patients in this study was low, observed at 13.6%, predominantly mild to moderate with normocytic morphology, indicating patterns typical of anemia of chronic disease and iron deficiency. So, implement routine anemia screening as an integral component of tuberculosis (TB) patient assessment to ensure early identification and management of hematologic complications.

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