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Prevalence of anaemia among symptomatic pulmonary tuberculosis patients at Weija Gbawe Municipal Hospital in Accra, Ghana

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Abstract

In Ghana, TB remains a substantial healthcare challenge, with an incidence rate of 136 cases per 100,000 people. Anaemia is prevalent among TB patients, impacting their health and recovery. Anaemia can lead to fatigue, weakness, and compromised immunity, all critical concerns for TB patients. This study aims to investigate the prevalence of anaemia among pulmonary TB patients at Weija Gbawe Municipal Hospital in Accra, Ghana.

Among the participants, 22.6% were found to have pulmonary TB, with the majority not showing resistance to rifampicin (95.5%), a primary treatment drug. Females had a higher prevalence of TB (53.3%), possibly due to hormonal and social factors. Participants over 66 years had a high prevalence, likely due to weakened immune systems associated with aging. Anaemia was prevalent among participants, especially females, and it was more common among TB patients (68.8%) compared to non-TB patients. Normocytic anaemia was the most common type among TB patients, followed by microcytic anaemia, suggesting potential iron metabolism issues.

This study provides valuable insights into the prevalence of anemia among TB patients and the distribution of different types of anaemia in this population. Understanding these factors can aid in better management and treatment of TB patients.

Keywords: Pulmonary Tuberculosis; Anaemia; Underweight; Diagnosis; GeneXpert

1. Introduction

Tuberculosis (TB) is an enduring and debilitating infectious disease that continues to be a formidable global public health challenge, particularly in developing nations [1, 2]. Globally, TB ranks as the 13th leading cause of death and stands as the second most lethal infectious disease, following closely behind COVID-19, surpassing even HIV/AIDS [3].

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Prior to the emergence of the COVID-19 pandemic in 2020, TB held the unfortunate distinction of being the primary cause of mortality attributed to a single infectious agent [4,5].

TB predominantly targets the respiratory system, with clinical presentations marked by hallmark symptoms, including cough (with or without sputum production), intermittent fever, unexplained weight loss, reduced appetite, and hemoptysis (coughing up blood) [6]. According to the World Health Organization (WHO), there were approximately 10.6 million reported cases of tuberculosis worldwide in 2021 [7]. This figure comprises 6 million cases in men, 3.4 million cases in women, and 1.2 million cases in children [8]. Tragically, tuberculosis claimed the lives of 1.6 million individuals in 2021, with 187,000 of those cases occurring in people living with HIV [4,6]. Despite its global ubiquity and impact across various countries and age groups, it's vital to underscore that tuberculosis is a disease that is both treatable and preventable, as emphatically stated by [9,10].

Despite unwavering efforts and commendable progress in controlling TB infections, the disease remains a substantial challenge for the healthcare system in Ghana [11, 12]. The incidence rate stands at 136 cases per 100,000 people, as reported by the World Health Organization in 2022 [9]. It is estimated that over 46,000 new cases of active TB infections occur annually, leading to a mortality rate of approximately 7.5% per 1,000 infected individuals [13,14].

Anaemia is a prevalent condition among individuals diagnosed with pulmonary tuberculosis (TB) and can arise from various factors, including reduced production of erythropoietin, chronic inflammation, malnutrition, and blood loss [15,16]. Notably, chronic inflammation and iron deficiency have been identified as primary contributors to the development of anaemia in individuals with TB [17,18,19]. However, it is worth noting that distinguishing between these two factors can be challenging, particularly in developing countries where both conditions are widespread [20,21]. Anaemia can significantly impact the health and well-being of TB patients, potentially exacerbating the challenges associated with TB treatment and recovery [22,23]. Anaemia can lead to fatigue, weakness, and a compromised ability to combat infections, all of which are critical considerations for individuals already grappling with TB [24,25].

In Ghana, there is a significant lack of data concerning the prevalence of anaemia among individuals diagnosed with tuberculosis (TB) at the time of diagnosis [26,27]. Given the heterogeneous nature of TB and its interactions with various health factors, it becomes imperative to systematically screen for anaemia in individuals with TB and implement timely interventions [28.29]. Therefore, the aim of this study is to investigate the prevalence of anaemia among pulmonary tuberculosis patients and their associated risk factors among patients at Weija Gbawe Municipal Hospital, Accra.

2. Methods

2.1. Study design and population

This was a cross-sectional study which focused on patients seeking medical care at the Outpatients Department (OPD) of Weija Gbawe Municipal Hospital who exhibit symptoms suggestive of pulmonary tuberculosis and undergo initial screening.

2.2. Study area

This study was conducted at the GeneXpert Testing Centre and Hematology unit of the Weija-Gbawe Hospital Laboratory, in the Weija-Gbawe Municipality, Accra, Ghana. According to the 2021 Ghana Population and Housing Census (PHC), the municipality has a population of 213,674, comprising 108,764 females and 104,910 males. Geographically, the Weija-Gbawe Municipality is located in the southwestern part of Accra, situated between 5°47'30"N and 5°27'30"N latitude and 0°31'30"W and 0°16'30"W longitude [30].

The Weija-Gbawe Municipal Hospital (WGMH), formerly known as Ga South Municipal Hospital or "Alkawe Hospital," has earned recognition as the best-performing hospital among its peers, based on a ranking system established by the Ghana Health Service (GHS) [27]. The hospital employs a total of 576 health workers, including 380 clinicians and 196 non-clinicians. Located within the Weija-Gbawe Municipality, it experiences a daily admission rate of approximately 60 to 100 patients, with over 300 patients attending the facility's out-patient departments (OPDs) on a daily basis. Notably, according to the 2022 Weija Gbawe Municipal Health Directorate annual review on TB, out of the total OPD attendance, 904 patients (0.7%) were screened, suspected, and tested for tuberculosis, resulting in the diagnosis of pulmonary tuberculosis in 83 patients (9.2%) [27].

2.3. Sample size determination

Using the formular: $N=\frac{Z^2 \times P(1-P)}{d^2}$

Where;

N= is sample size
Z = is confidence of interval of 95% (standard value of 1.96)
P= prevalence of 136 per 100000 people (13.6%)
d= margin of error (standard value of 0.05)

$\frac{(1.96)^2 \times 0.136(1-0.136)}{(0.05)^2} = \frac{0.45140337}{0.0025} = 180.56 = 181$

Hence, the minimum sample size was 181, however 199 participants were recruited for this study with expectation of few patients who might opt out of the research or have incomplete data [31].

2.4. Data collection

A structured questionnaire that sought for demographic data, medical history and symptoms were administered to the volunteered participants through face-to-face interview. The participants' weight and height were measured using a weighing scale and meter ruler respectively, and body mass index (BMI) was computed using the formula: BMI = (weight in kilograms)/ (height in centimeters)^2 [32]. BMI was graded as: underweight (<18.5 kg/m^2), normal (18.5–24.9 kg/m^2) and overweight (≥25.0 kg/m^2) [33]. Participants were also educated to void spot sputum samples into sterile containers approved by the national tuberculosis control program and WHO. Only good quality mucopurulent sputa from patients with clinical manifestations such as cough and fever were enrolled in this study. Blood samples (3-5 ml) were collected from all participants via venipuncture into K_2EDTA vacutainer tubes.

2.5. Laboratory investigation

Sputum samples were processed using Cepheid's GeneXpert MTB/RIF Ultra Assay. This is an advanced highly sensitive and specific RT-PCR-based assay used to amplify the nucleic acid, detect the presence of the MTBC and resistance to rifampicin in sputum samples. The results were interpreted as MTB not detected if negative, MTB detected with grading either (very low, low, medium, or high) with RIF resistance not detected or RIF resistance detected [34,35].

On the other hand, 6 microliters of the whole blood were used for thick blood smears to confirmed Malaria infection. While, full hemogram was performed for each participant with the remaining well-mixed anticoagulated whole blood specimen using Sysmex 5-fully automated part hematology analyzer following standard procedures. Anaemia was defined as a hemoglobin level of <13.0 grams per deciliter (g/dl) for males and <12.0 g/dl for females and graded as mild (11.0–12.9 g/dl for men and 11.0–11.9 g/dl for females), moderate (8.0–10.9 g/dl for both sexes) and severe (<8.0 g/dl for both sexes) [36]. Anaemia is classified as hypochromic if the mean corpuscular hemoglobin (MCH) is <24 picograms (pg). Microcytosis is defined as a mean corpuscular volume (MCV) of <76 femtolitres while macrocytosis is an MCV of >96 fl [37]. HIV and sickling status of participants were obtained from medical records.

2.6. Data management and analysis

Data Management and Data Analysis was done using, the data gathered from the questionnaires were entered and saved in Microsoft Excel 2016 and transported into SPSS version 25.0 software for analysis. Tables and graphs were used to display the data. Descriptive statistics was used to summarize the data into frequencies and percentages. The significant association was determined using the chi square test. Multiple logistic regression models were run for statistically significant variables to determine the significant risk factors. Statistical significance threshold was set at $p < 0.05$.

3. Results

3.1. Socio-demographic characteristics of study participants

The study included a total of 199 participants visiting the Outpatients Department (OPD) of Weija Gbawe Municipal Hospital in Acra, the capital of Ghana. These participants lived in diverse areas in Accra, including; Gbawe, Tuba, Lapaz, Ablekuma and Dansoman. A total of 51.3% (102/199) of the participants were males and 48.7% of the participants were females **(Table 1)**.

The participants' mean (SD) age was 32.17 (±2.691) years and most of the participants were between the ages of 26 - 45 years 62/199 (32.1%), followed by those between 1- 25 years 49/199 (24.6%). About 50/199 (24.1%) of the participants were also >66 years **(Table 1)**.

Clinical presentations of the study participants were: Cough more than 2 weeks (33.6%), Chest pain (38.1%), Night sweats (28.1%) and Fever was the most predominant clinical symptom among the participants (47.7%). A total of 30.6% of the study participants had underweight. However, a few of the participants (6.0%) had abnormal chest x-ray report **(Table 1)**.

The medical history of the participants indicated that, a significant lower percent of 1 and 3.5 of the participants had HIV and malaria respectively **(Table 1)**.

Table 1 Socio-demographic characteristics of study participants

Characteristics	Total number (n)	Percentage (%)
Gender		
Male	102	51.3%
Female	97	48.7%
Age		
1-25 years	49	24.6%
26-45 years	62	32.1%
46-65 years	38	19.1%
>66 years	50	24.1%
Symptoms		
Cough more than 2 weeks	67	33.6%
Cough of any duration	60	30.1%
Chest pain	76	38.1%
Underweight	61	30.6%
Night sweats	56	28.1%
Fever	95	47.7%
Abnormal chest x-ray	12	6.0%
Infections		
Malaria	7	3.5%
HIV	2	1.0%

3.2. Prevalence of pulmonary tuberculosis among the study participants

A total of 45 out of 199 participants were found to be positive for pulmonary tuberculosis giving a prevalence of 22.6% (n = 45/199; 95% Cl 21.3-27.8). Cepheid's GeneXpert MTB/RIF Ultra Assay analysis showed that 95.5% (43/45) of the pulmonary tuberculosis patients were not resistance to rifampicin. However, 4.5% (2/45) were found to be indeterminate (**Figure 1**).

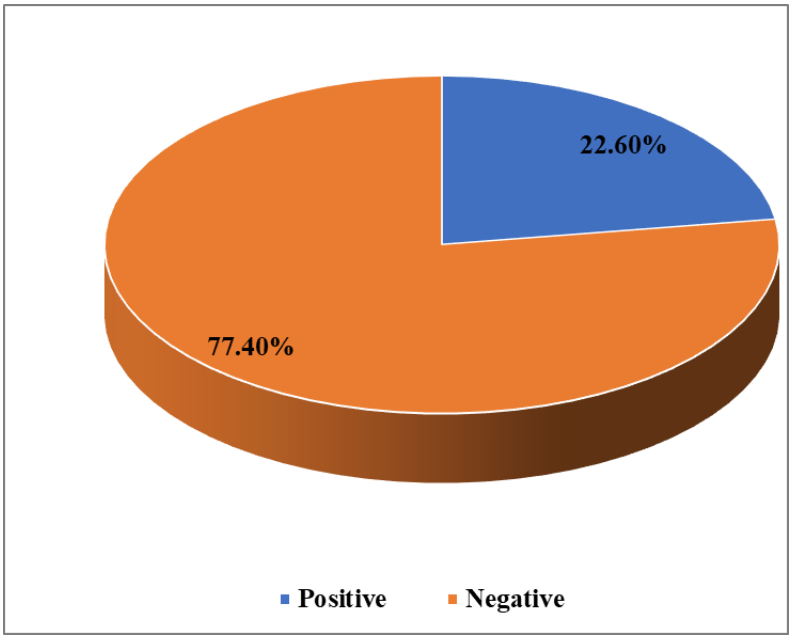

Figure 1 Prevalence of pulmonary tuberculosis among study participants

3.3. Prevalence of anaemia among study participants

In this study, the average haemoglobin (Hb) mean (±SD) was 11.420 (±1.165). A total of 109 out of the 199 participants were anaemic, resulting in a prevalence of 54.7% (n = 109/199; 95% Cl 51.3-84.9). The prevalence rates of mild (11.0–12.9 g/dl for men and 11.0–11.9 g/dl for females), moderate (8.0–10.9 g/dl for both sexes) and severe (<8.0 g/dl for both sexes) were 40.3% (44/109), 55.9 % (61/109) and 3.6% (4/109), respectively.

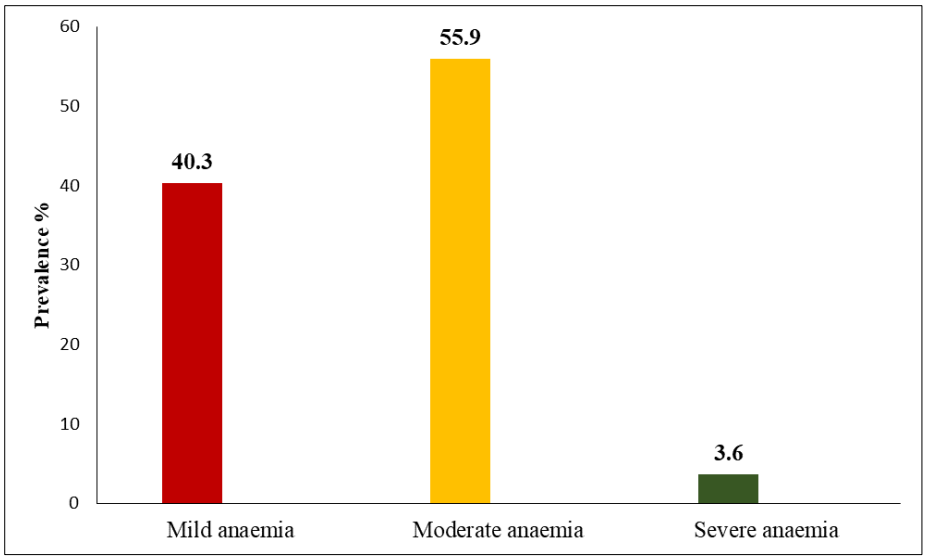

Figure 2 Prevalence of anaemia among study participants

3.4. Prevalence of pulmonary tuberculosis, anaemia and their relation with demographic and clinical factors

In this study, high prevalence of pulmonary tuberculosis (53.3%: 24/45) was obtained among male participants compared to female (46.6%: 21/45). This was because, female participants had a lower risk of pulmonary tuberculosis (OR= 1) than male participants. However, there was no significant association between pulmonary tuberculosis and gender p = 0.731) (**Table 2**). Again, there was no significant association between age group and pulmonary tuberculosis in this study (p = 0.319), but participants between 26-45 years had an increased risk of pulmonary tuberculosis with (OR=1.42, 95% CI:0.45-2.93) at a prevalence of (11.2%:7/62) compared to other age groups **(Table 2)**.

A total of 58.3% of participants with abnormal chest x-ray were found to be significantly associated with pulmonary tuberculosis in this study (p = < 0.001). However, patients with symptom of chest pain had an increased risk of pulmonary tuberculosis (OR= 2.91, 95% CI: 2.25-4.30). The current study observed that, participants with a medical history of HIV were significantly associated with pulmonary tuberculosis (p = 0.000) **(Table 2).**

High prevalence of anaemia was found among female participants (56.9%) compared to their male counterparts (43.1%). Also, a significant association was found between anemia and female participants, (p = 0.003) **(Table 2).** Anaemia was common among participants between 26 to 45 years of age (75.8%). However, participants more than 66 years had an increased risk of anaemia compared to other age groups (OR= 2.25, 95% CI: 0.86-5.87) **(Table 2).** High prevalence of anaemia was found among participants with underweight (77.0%) and chest pain (50.0%) respectively. However, participants with fever (49.4%), were significantly associated with anaemia (p = <0.001). These findings are summarized in **Table 2**. Among the 22.6% (45/199) participants with pulmonary tuberculosis in this study, a total of 68.8% (31/45) of them had anemia. Out of the 68.8% pulmonary tuberculosis patients with anemia, 41.9% (13/31) had mild anaemia, 51.6% (16/31) had moderate anaemia and 6.4% (2/31) had severe anaemia respectively. These are summarized in **figure 3**.

Table 2 Logistic regression analysis showing prevalence of pulmonary tuberculosis, anaemia and their relation to demographic and clinical factors.

Variables	**Pulmonary tuberculosis**		**Anaemia**	
	Positive N (%)	OR (95 % CI) P value	Positive N (%)	AOR (95%CI) P value
Gender		0.731		0.020 Ref
Male	24/45 (53.3)	1.82 (0.45-2.43) 0.401	47/109(43.1)	0.73 (0.55-1.63) 0.003*
Female	21/45 (46.6)	Ref	62/109 (56.9)	
Age group		0.391		0.313
1-25 years	5/49 (10.2)	Ref	32/49 (65.3)	Ref
26- 45 years	7/62 (11.2)	1.42 (0.45-2.93) 0.097	47/62 (75.8)	0.43 (0.17-2.83) 0.260
46- 65 years	10/38 (26.3)	0.23 (0.31-1.90) 0.186	21/38 (55.2)	1.64 (0.65-4.16) 0.301
> 66 years	23/50 (46.0)	1.33 (0.65-2.91) 0.114	9/23 (39.1)	2.25 (0.86-5.87) 0.090
Symptoms		<0.001		<0.001
Cough more than 2 weeks	17/67 (25.3)	Ref	29/67 (43.2)	Ref
Cough of any duration	11/60 (18.3)	0.15 (0.02-1.09) 0.193	47/60 (78.3)	1.54 (0.65-3.15) 0.301
Chest pain	29/76 (38.1)	2.91 (2.25-4.30) 0.070	38/76 (50.0)	1.25 (0.86-5.17) 0.090
Underweight	16/61(26.2)	0.25 (0.17-2.99) 0.073	47/61 (77.0)	0.92 (0.65-1.30) 0.251
Night sweats	5/56 (8.9)	0.83 (0.65-1.30) 0.251	32/56 (57.1)	0.21 (0.17-2.99) 0.093
Fever	30/ 95 (31.5)	0.30 (0.77-2.49) 0.093	47/95 (49.4)	1.91 (0.65-3.20) <0.001*
Abnormal chest x-ray	7 /12 (58.3)	1.91(0.65-3.31) <0.001*	4/12 (33.3)	0.05 (0.19-2.89) 0.163
Infections		0.018		<0.001
Malaria	3/7 (42.8)	Ref	4/7 (57.1)	1.21 (0.35-3.30) <0.001*
HIV	1/2 (50)	0.91 (0.65-1.30) <0.001*	-	Ref

N= number of positives, AOR = adjusted odd ratio, * = significant association.

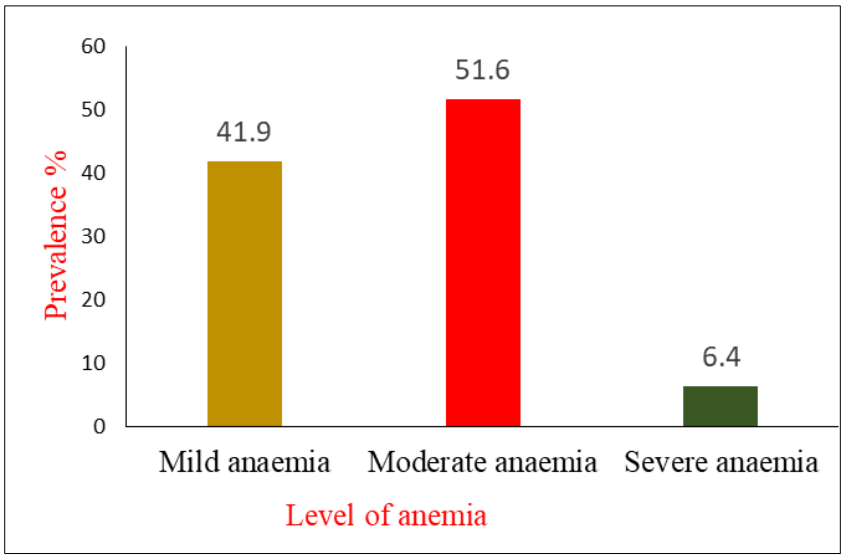

Figure 3 Prevalence of anaemia among participants with pulmonary tuberculosis

3.5. Prevalence of anaemia among pulmonary tuberculosis and non-pulmonary tuberculosis patients.

This research found that the most common morphological class of anaemia among pulmonary tuberculosis patients was normocytic anaemia, accounting for 66.6% (30/45) of the cases. This was followed by microcytic anaemia 28.8% (13/45) and macrocytic anaemia 4.4% (2/45). The findings of this study revealed a higher prevalence of normocytic anaemia 73% (112/154), followed by microcytic anaemia 24% (37/154) and macrocytic anaemia 3% (5/154) among the non-pulmonary tuberculosis patients (**Figure 4**).

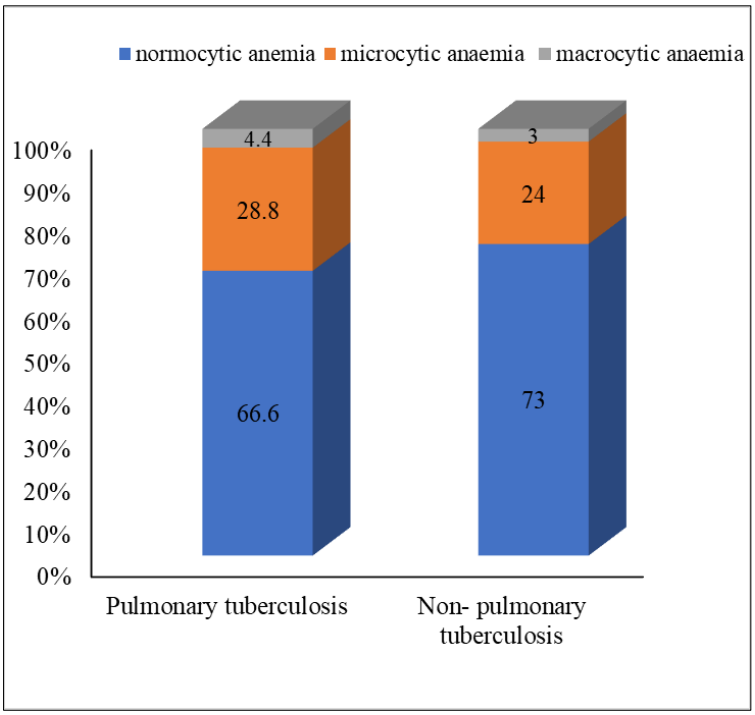

Figure 4 Morphological classes of anaemia among pulmonary tuberculosis and non- pulmonary tuberculosis patients.

4. Discussion

In this study, 22.6% (45/199) of the participants were found to be positive for pulmonary tuberculosis. This prevalence of pulmonary tuberculosis is similar to that reported in Ethiopia (22.4%) [36] and Spain (24.3%) [37]. However, it is lower than the 31.4% which was reported by Boakye-Appiah et al., [28] in Ghana, and in Croatia (40.7%) [38].

The GeneXpert MTB/RIF Ultra Assay is a diagnostic test used to detect Mycobacterium tuberculosis (the bacterium causing tuberculosis) and rifampicin resistance [21,39]. Out of the 45 participants with pulmonary tuberculosis, the assay showed that 95.5% (43 out of 45) of them were not resistant to rifampicin, which is an important first-line drug for treating tuberculosis [40]. This is a positive finding as it suggests that the majority of patients can be effectively treated with standard first-line medications. However, 4.5% (2 out of 45) were found to have indeterminate results with the GeneXpert MTB/RIF Ultra Assay. An indeterminate result means that the test couldn't definitively determine whether the patient was resistant or not. This might be due to various factors such as low bacterial load or technical issues with the assay. These cases would likely require further testing or clinical evaluation to determine the appropriate treatment approach.

The study found a higher prevalence of pulmonary tuberculosis among female participants (53.3%) compared to male participants (46.6%). The higher prevalence of pulmonary tuberculosis among females might be attributed to various factors such as hormonal differences, social and cultural factors affecting healthcare-seeking behavior, and possibly occupational exposure [41].

Participants > 66years had a high prevalence of pulmonary tuberculosis (46%) compared with the other age groups but those between 25-45 years had an increased risk of pulmonary tuberculosis than the > 66years group. The increased prevalence of pulmonary tuberculosis among participants above 66 years might be linked to their weakened immune systems due to aging, making them more susceptible to tuberculosis infection [42,43]. Participants with abnormal chest X-rays had a significantly higher prevalence of pulmonary tuberculosis (58.3%) compared to those without abnormal X-rays. An abnormal chest X-ray is a common diagnostic tool used to detect pulmonary tuberculosis [44]. The presence of abnormalities on the X-ray likely indicates active tuberculosis infection or related lung pathology, leading to a strong association between abnormal X-rays and pulmonary tuberculosis [8,45].

Participants with a medical history of HIV were significantly associated with pulmonary tuberculosis ($p = < 0.001$). This is similar to what was reported by Murray et al., [46]. HIV weakens the immune system, making individuals more susceptible to various infections, including tuberculosis [47]. HIV infection significantly increases the risk of latent tuberculosis infection progressing to active tuberculosis disease. This association is well-established in the medical literature [42].

A total prevalence of 54.7% of the participants were anaemic. This is higher than the 21% reported by Siva et al., [48]. One of the leading causes of anaemia is a deficiency in essential nutrients like iron, vitamin B12, and folate [49]. These nutrients are necessary for the production of hemoglobin and red blood cells [50]. Inadequate intake or absorption of these nutrients can lead to anaemia. Certain chronic diseases, such as chronic kidney disease and inflammatory disorders, can interfere with the body's ability to produce red blood cells, leading to anaemia [51]. The study found a higher prevalence of anaemia among female participants (56.9%) compared to males (43.1%). The reason behind this gender disparity is likely due to physiological differences. Women are more susceptible to anaemia due to menstrual blood loss and higher iron requirements during pregnancy. Hormonal differences and dietary factors can also contribute to this disparity [52,53].

It was found in the study that the proportion of anaemia among the TB patient was 68.8%. This is almost similar to the 75.2% reported in a selected hospital of Dhaka city, Bangladesh [54]. This association could be due to the impact of tuberculosis on the body's nutritional status and immune response. Chronic infections like TB can lead to inflammation and reduced nutrient absorption, which are contributing factors to anemia [55].

The results of the study provide valuable insights into the distribution of different morphological types of anaemia among both pulmonary TB and non-TB patients. The study found that among pulmonary TB patients, normocytic anaemia was the most common morphological class, accounting for 66.6% of the cases. This is similar to the 66.6% reported by Vijay et al., [56]. This indicates that a significant proportion of TB patients exhibited a normal size of red blood cells along with reduced haemoglobin levels.

Following normocytic anaemia, microcytic anemia was the second most common type among pulmonary TB patients, with a prevalence of 28.8%. Microcytic anaemia is characterized by smaller than normal red blood cells and is often associated with iron deficiency [57]. The presence of microcytic anaemia in TB patients suggests that iron metabolism may be affected, possibly due to factors such as inflammation or poor nutritional intake [58]. Macrocytic anaemia, characterized by larger than normal red blood cells, was the least common among pulmonary TB patients, with a prevalence of 4.4%. The relatively low prevalence of macrocytic anaemia in TB patients suggests that these specific nutrient deficiencies might not be widespread in this group.

List of abbreviations

- TB: Tuberculosis;
- WHO: World Health Organization;
- OPD: Outpatient department;
- PHC: Population and housing census;
- GHS: Ghana health service;
- BMI: Body mass index;
- Hb: Haemoglobin;
- MCV: Mean corpuscular volume.

5. Conclusion

In conclusion, this study has provided valuable insights into the prevalence of pulmonary tuberculosis and its association with various factors, including age, gender, HIV status, and anaemia. The findings reveal a significant burden of pulmonary tuberculosis in the study population. The majority of individuals with pulmonary tuberculosis were not resistant to rifampicin, which is a positive outcome as it suggests that standard first-line medications can be effectively used for treatment.

The association between anaemia and tuberculosis suggests that nutritional interventions and anaemia management should be integrated into the care of tuberculosis patients to improve their overall health outcomes. The study also categorized the morphological types of anaemia among pulmonary tuberculosis patients, with normocytic anaemia being the most common, followed by microcytic anaemia and a lower prevalence of macrocytic anaemia. These findings provide insights into the specific nutritional and physiological factors that may contribute to anaemia in tuberculosis patients, which can inform targeted interventions to address these issues.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare that they have no competing interests

Statement of ethical approval

Ethics approval was sought from the Ethics and Protocol Review Committee of School of Biomedical and Allied Health Sciences at University of Development Studies, and the authorities of Weija-Gbawe Municipal Hospital through the regional and district directors of Ghana Health Service respectively. The study objectives and procedures, as well as possible risks/benefits associated with participating in the study were carefully explained in English and the local language to the participants before they were recruited into the study. All methods were carried out in accordance with relevant guidelines and regulations.

Statement of informed consent

They were informed that they had the right to stop at any point in the study.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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