NUTRITIONAL STATUS AND ITS ASSOCIATION WITH TB TREATMENT OUTCOME AMONG PATIENTS ON ANTI-TB TREATMENT IN GARDO TB CENTER SOMALIA IN 2024; RETROSPECTIVE COHORT STUDY

MPH THESIS

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ABBREVIATIONS AND ACCRONYMS

AIDS	Acquired Immune Deficiency Syndrome
AOR	Adjusted Odd Ratio
COR	Crude Odd Ratio
DOTS	Directly Observed Treatment Strategy
DRTB	Drug-Resistance Tuberculosis
HIV	Human Immune Deficiency Virus
MAM	Moderate Acute Malnutrition
MDGS	Millennium Development Goals
MDRTB	Multi-Dug Resistance Tuberculosis
PTB	Pulmonary Tuberculosis
SAM	Severe Acute Malnutrition
SDG	Sustainable Development Goal
TB	Tuberculosis
TSR	Treatment Success Rate
WHO	World Health Organization

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ABSTRACT

Background: Malnutrition is strongly linked to tuberculosis, acting as both a risk factor for developing the disease and a consequence of active infection. In Somalia, widespread food insecurity and limited access to healthcare further exacerbate this problem. However, there is limited evidence examining the association between nutritional status and TB treatment outcome. Assessing patients' baseline nutritional status in relation to their treatment outcomes is crucial, as it can help inform targeted nutritional interventions that may significantly improve TB treatment success rates and overall patient recovery

Objectives: To assess nutritional status and its association with Tuberculosis treatment outcome among patients on Anti-TB therapy at Gardo Tuberculosis treatment center 2024.

Methods: A retrospective cohort study was conducted among 510 randomly selected individuals on anti-tuberculosis treatment (260 malnourished and 250 well-nourished patients) at the Gardo Tuberculosis Center in Somalia. Patient data were extracted from medical records using a checklist based on national treatment guidelines and recording forms. Nutritional status was assessed using Body Mass Index (BMI), which was readily available in the patient cards. Differences in treatment outcomes (successful and unsuccessful) were calculated and compared between well-nourished and malnourished patients using proportions. Multiple logistic regression was fitted to control for confounding factors in the association between nutritional status and treatment outcomes, with a 5% significance level..

Results: A total of 924 patients were diagnosed with tuberculosis during the study period, of whom 421 were undernourished and 503 were well-nourished. Of these, 510 patients (260 well-nourished and 250 undernourished) were included in the assessment of tuberculosis treatment outcomes. Overall, 70.4% (95% CI: 66.2%–74.2%) of the patients achieved a successful treatment outcome. The treatment success rate was 58.0% (95% CI: 51.6%–63.7%) among undernourished individuals and 82.3% (95% CI: 78.5%–87.7%) among well-nourished individuals. The adjusted odds ratio indicated that being well-nourished at baseline was associated with significantly higher odds of achieving a successful tuberculosis treatment outcome (AOR = 4.0; 95% CI: 2.4–6.5).

Conclusion: This study revealed that substantial proportion of patients at center were undernourished during treatment. Moreover well-nourished patients have higher chance of success after TB treatment indicating nutritional status is an important factor contributing to favorable treatment outcomes among tuberculosis patients. Integration of nutritional assessments and targeted interventions for under nutrition, should be prioritized within tuberculosis treatment frameworks to improve patient outcomes.

Key words: Nutritional status, Tuberculosis, Treatment outcome, Somalia

1. INTRODUCTION

1.1 Background

Tuberculosis is an infectious disease caused by the bacillus Mycobacterium tuberculosis(López-López et al., 2021). The principal source of infection is an untreated smear-positive pulmonary tuberculosis (PTB) patient who releases infectious bacilli into the air. Although tuberculosis primarily affects the lungs (pulmonary TB), it can also involve other anatomical sites, leading to extra pulmonary manifestations (Olmo-Fontánez and Turner, 2022).

TB still affects millions of people worldwide; in 2023, an estimated 10.8 million new cases were reported (Emegano et al., 2025). Around 98% of cases worldwide occur in low- and middle-income nations which carry the greatest burden (Balakrishnan et al., 2021). Development Goals include ending the tuberculosis epidemic by 2030 (Sinha et al., 2019).

Treatment for TB aims to cure patients, prevent transmission, and reduce mortality rates. However, TB treatment often poses challenges, requiring patients to adhere to a regimen of multiple medications for at least six months(Sulis et al., 2016). The success of treatment hinges on the susceptibility of the Mycobacterium tuberculosis strains to anti-TB drugs, with multidrug-resistant TB (MDR-TB) requiring second-line drugs and prolonged treatment durations(Téllez-Navarrete et al., 2021).

Under nutrition is a significant contributing factor to TB treatment failure, with an estimated 25% of new cases worldwide attributed to under nutrition (WHO, 2024) The relationship between under nutrition and TB is bidirectional, with under nutrition increasing the risk of TB development and active TB exacerbating weight loss(He et al., 2020). Analyzing nutritional status is crucial for improving TB treatment outcomes, with nutritional support potentially enhancing the effectiveness of directly observed treatment strategies (DOTS) (Simieneh et al., 2024).

1.2 Statement Of The Problem

Tuberculosis continued to be the most frequent infectious pathogen-related cause of death in 2019. An estimated 10.0 million individuals worldwide contracted tuberculosis in 2019 (Chakaya et al., 2021).

Undernourished patients have increased severity of disease, which in turn increases the risk of death and severe under nutrition at diagnosis(Padmapriyadarsini et al., 2016) Under nutrition speeds up the progression of TB from infection to active tuberculosis. In addition, under nutrition is associated with increased risk of death and relapse of the disease(Simon Schaaf et al., 2012).

People with tuberculosis who are undernourished have greater bacillary grade sputum and increased cavitation, In undernourished PWTB, pharmacotherapy may not be as effective because of decreased isoniazid and rifampin absorption or higher toxicity from aminoglycosides and ethambutol(Sinha et al., 2023).

A few studies found that the percentage of TB patients who were malnourished varied from 52 to 90% in low-income nations outside of SSA countries, 43–78% in SSA, and 27.2% to 84.4% in Ethiopia. Under nutrition among TB patients has been linked to a number of factors SSA countries including: food insecurity, low socioeconomic status: lack of employment, lack of formal education, availability of food supplements during TB treatment, unsanitary surroundings, and HIV/TB coinfection(Tesfaye Anbese et al., 2021).

Somalia has one of the highest rates of tuberculosis incidence worldwide and is also one of the world's poorest and most violent nations, In Somalia, tuberculosis is one of the leading causes of morbidity and mortality as well as a significant health burden. A number of 6,458 TB-related deaths, or 5.03% of all deaths, were reported in Somalia. The age-adjusted death rate of TB is 123.01 per 100,000 population, ranking fourth in the world (Ali et al., 2017).

There is limited evidence available from Somalia regarding the nutritional status of TB patients and treatment outcomes. Therefore, this study aims to fill this research gap by assessing nutritional status and its association with treatment outcomes at the Gardo TB Treatment Center in Puntland, Somalia.

1.3 Significance Of The Study

The beneficiaries of this study will be:

✓ **The local health bureaus:** could benefit from insights into the nutritional status of TB patients and its association with treatment outcomes.

✓ **The hospital:** Understanding the nutritional landscape allows health authorities to develop specific interventions and support programs to meet patients' needs. - This can improve TB treatment outcomes and reduce complications.

✓ **The healthcare providers** The findings can contribute to the creation of targeted nutritional guidelines and strategies. This ensures healthcare providers have evidence-based tools to improve patient care and enhance treatment success.

1.4 Objectives Of The Study

1.4.1 General Objective

- To assess nutritional status and its association with success of Tuberculosis (TB) treatment outcomes among patients undergoing anti-TB treatment at Gardo Center Somalia.

1.4.2 Specific Objectives

- To determine the nutritional status of TB patients undergoing anti-TB treatment at Gardo Center
- To assess the association between nutritional status and treatment outcome among TB patients in Gardo center

2. LITERATURE REVIEW

2.1 Nutritional Status Among TB Patients

Nutritional status is a critical determinant of susceptibility to tuberculosis (TB) and an important factor influencing disease progression and recovery. Numerous studies conducted across different settings consistently demonstrate a high burden of undernutrition among individuals diagnosed with TB.

In rural central India, the study conducted was found under-nutrition was the most prevalent comorbidity, present in more than 85% of rural men and women with pulmonary TB at diagnosis(Bhargava et al., 2013).another cross-sectional study conducted in Bokhara Nepal to assess dietary intake and nutritional status of TB patients was found that: relatively, a higher percent of patients were underweight (21.8%) than overweight (17.3%)(Gurung et al., 2018).

Evidence from West Africa also highlights the extent of this problem. The study conducted Burkin Faso to assess the nutritional status of the patients with the TB shows that, in TB patients undergoing anti-TB treatment, 35.8% suffered from under nutrition, and 2.6% were overweight(Musuenge et al., 2020).

In Ethiopia, several studies have documented a high prevalence of undernutrition among TB patients. The cohort study conducted in the Addis Ababa to investigate nutritional status and TB treatment outcome was found Most of the patients (95.39%) were newly diagnosed with TB; 167(90.76%) in the underweight group and 268(98.53%) in the normal or overweight group(Sahile et al., 2021) Additionally the Study conducted Addis Ababa was found One hundred thirty-one patients (46.5%) were under nutrition at the time of registration; 54 (19.0%) having severe under nutrition and 78 (27.4%) moderate under nutrition(Seid and Ayele, 2020b).another study was showed the prevalence of under nutrition was found to be 39.7 %, of this 23.6 % have mild, 8.6 % moderate and 7.2 % severe under nutrition. Furthermore, greater than half of the respondents 193 (53.6 %) had normal weight based on BMI classification(Dargie et al., 2016).

Furthermore, the study conducted in the southern Ethiopia was found Ninety-six study participants had a BMI less than 18.5 kg/m2 96 (38.9%) (under nutrition), whereas only one study participant had a BMI greater than or equal to 25 kg/m2 (overweight). the study participants with weight less or equal to 45 kg were 21 (8.5%)(Geberemeskel et al., 2018).

Overall, the existing literature consistently demonstrates that undernutrition remains a major comorbidity among TB patients across low- and middle-income countries, underscoring the need for routine nutritional assessment and intervention in TB programs.

2.2 Association Between Nutritional Status And TB Treatment Outcomes

The relationship between nutritional status and TB treatment outcomes has been well established in multiple studies. Adequate nutrition supports immune function, treatment adherence, and tissue recovery, whereas undernutrition increases the risk of delayed sputum conversion, treatment failure, relapse, and mortality.

Retrospective study conducted in west Bengal India to assess relationship between nutritional support and TB treatment outcome was found that of the 173 TB patients who were supported by nutrition, 15 (9%) had unsuccessful treatment outcomes, and 84 (21%) of those who were not provided nutrition support had unsuccessful treatment outcomes(Samuel et al., 2016).

In the study conducted Uganda was shown the overall treatment success rate (TSR) was 71.4% (n = 197). Although the TSR was similar among people with DRTB and mild (71.7%), moderate (78.3%) and severe (67.0%) under nutrition (p = 0.258), all treatment failure cases (n = 6) were among people with severe under nutrition (p = 0.010). The overall (n = 79) median (95% CI) time to an unfavorable outcome (treatment failure, death and loss-to-follow-up combined) was 5 (2–7) months(Baluku et al., 2021).

According to the research conducted in Ethiopia, Addis Ababa 2021 to investigate nutritional status and TB treatment outcome among TB patients was found that The proportion of unsuccessful treatment outcomes among underweight and normal or overweight patients was 14.7% (27/184) and 6.6% (18/272), respectively(Sahile et al., 2021). Another study conducted in Ethiopia, Oromia region, was found that Among patients on TB treatment who had faced malnourished were [AOR = 6.3, {95%CI (1.8–2.4)] more likely to be unsuccessful than those who had well nourished(Besheda et al., 2023). In the Study conducted Addis Ababa to assess under nutrition and mortality among TB patients was found the proportion of deaths by nutritional status during treatment as normal, MAM, and SAM TB patients was 3.1%, 8.9%, and 16.3%, respectively(Seid and Ayele, 2020b)

In the case-control study conducted Jimma south west Ethiopia was found those who were malnourished at the time of initiation of TB treatment had approximately 4.5 times more unsuccessful treatment

outcomes than those who were normal nutritional status (AOR= 4.5; 95% CI: 1.5–12.9)(Teka et al., 2023).

Collectively, these findings underscore the critical role of adequate nutritional status in improving treatment success and reducing mortality among TB patients.

2.3 Conceptual Framework

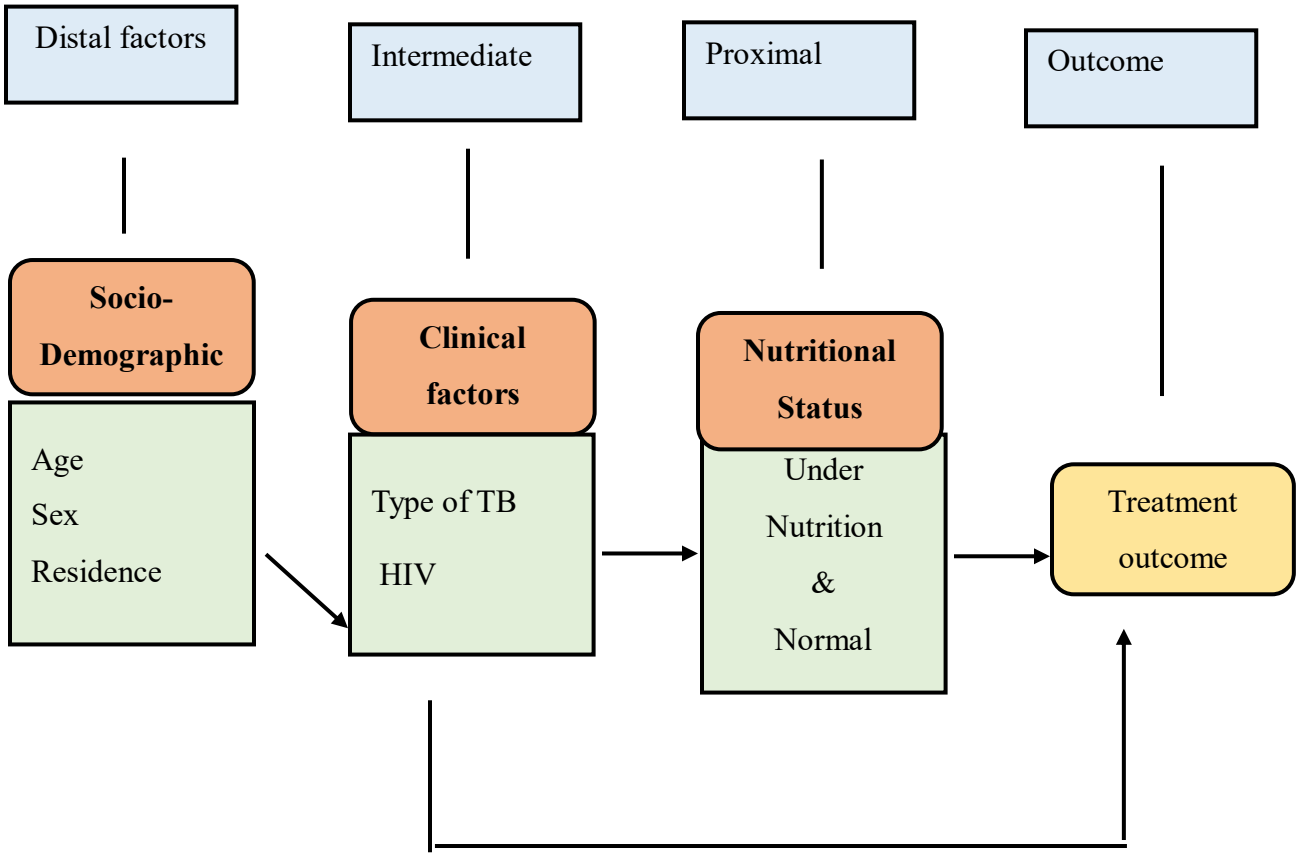

Figure 1 Conceptual framework among Assessment of nutritional status and TB treatment `outcome among adult patients on Anti TB treatment in Gardo TB center Puntland Somalia

Source this conceptual framework was developed after reviewing/reading various literature ((Bhargava et al., 2013), (Feleke et al., 2019) (Sahile et al., 2021).)

3. METHODS AND MATERIALS

3.1 Study Area And Period

The study was conducted at the Gardo TB Treatment Center located in Somalia using data from 2019 to 2024. Gardo is situated in the northeastern part of Somalia, and total population live in Gardo is 300,000 and the TB treatment center serves as a primary healthcare facility for the diagnosis and management of tuberculosis in the region. The center caters to a diverse population from various communities within its catchment area.

3.2 Study Design

Retrospective Cohort study was conducted among TB patients with malnutrition and those without malnutrition receiving anti-TB treatment.

3.3 Population

3.3.1 Source Population

The source population were all patients who have been diagnosed with TB and were on Anti-TB treatment during study period at Gardo TB treatment center, Somalia.

3.3.2 Study Population

The study population consisted of all tuberculosis patients who were receiving anti-TB treatment and had their BMI measured at the time of registration at the Gardo TB Treatment Center.

3.4 Inclusion And Exclusion Criteria

3.4.1 Inclusion Criteria

Persons of all ages diagnosed with TB disease who initiated anti-TB treatment at Gardo TB treatment center during study period.

3.4.2 Exclusion Criteria

This study excluded patients whose care was transferred out of the health facility due to incomplete follow-up, those diagnosed with MDR-TB because required different treatment protocols, which could skew outcomes.

3.5 Sample Size Determination

Sample size of first objectives

Sample size of the first objective was calculated using a single population proportion formula by considering the study was conducted Addis Ababa the prevalence of underweight among TB patients was 46.8% (95% CI: 54.80 -59.54%).(Seid and Ayele, 2020a)

Where n represents the minimum sample size required; z is 1.96, which is the standard normal value at the level of confidence desired (for a 95% confidence interval); d is 0.05, the acceptable error; and p, which is 0.468, was the estimated proportion of underweight patients. Based on the above assumption, the sample size was calculated as follows.

$$\text{Sample size } n = \frac{(z\alpha/2)^2(p)(q)}{d2}$$

$$n = \frac{(1.96)^2(0.468)(1-0.468)}{(0.05)2} = 383$$

Sample size of second objective to assess the association between nutritional status and treatment outcome among TB patients

The second objective was calculated using the following assumptions; confidence level of 95% (α= 0.05) and statistical power of 80% (β = 0.20). therefor treatment outcome from prior study conducted Addis Ababa (Sahile et al., 2021) was estimated unsuccessful treatment outcome was occur 14.7% and 6.6% for underweight and overweight or normal respectively. we estimated ratio 2:1 for underweight to overweight or normal patients.

Table 1: Sample size of second objective to assess the association between nutritional status and treatment outcome among TB patients.

Exposure status	Unsuccessful treatment Outcome	AOR	Sample size with 10% nonresponse	References
Underweight	14.7%	2.15	250	(Sahile et al., 2021)
Normal	6.6%	3.55	260	
Total			510	

After comparing the results of the calculated sample size, a larger sample size of 510 was taken for this study. By adding 10% non-response rate The final sample size is 510+51=561, after excluding 51 patients with incomplete information on the treatment outcome, 510 patients were included in the final analysis.

3.6 Sampling Procedure

Simple random sampling used to select 510 patients (250 from patients with malnutrition and 260 those without malnutrition) from a list of total patients on Anti-TB registered for Gardo TB center which accounts 924 from 2019-2024 of this 503 were had malnutrition and 421 were without malnutrition based on information of body mass index registered during initial treatment taken on registration logbook.

3.7 Data Collection Methods

3.7.1 Data Collection Instruments

The data were extracted from medical records using a checklist prepared based on national treatment guideline and recording form. The checklist that was designed in English to collect information from documents or records consist of sociodemographic variables such as age, sex, place of residence co-morbidities such as HIV. The data was collected using Kobo Toolbox software loaded on the data collector's smartphone.

3.7.2 Data Collectors And Supervisors

Data collectors and supervisors for this study include healthcare professionals with knowledge and experience in tuberculosis and nutrition, including two nurses, one nutritionist, and one medical doctor**.** The team of data collectors and supervisors was trained on the study objectives, data collection tools, ethical considerations, and data management processes to ensure a high standard of data quality.

3.7.3 Data Collection Procedure

Using the medical record numbers of patients diagnosed with tuberculosis in the registry, patient records were retrieved from the card room and reviewed. Patients' anti-TB treatment outcomes were measured accordingly..

3.8 Variables

3.8.1 Dependent variable

The dependent variable was treatment outcome of the patients who received Anti TB treatment.

3.8.2 Independent variable

The main independent variable was the nutritional status of TB patients who received Anti TB treatment. In addition, the confounding variables including: sex, age,residence,co-morbidities such as HIV.

3.9 Operational Definitions

Body Mass Index (BMI): Body Mass Index was used as an indicator of nutritional status among patients undergoing anti-TB treatment. the Body Mass Index (BMI), calculated from the patient's height and weight recorded during their first visit to the center, was used as a tool to assess their nutritional status(Zierle-Ghosh and Jan, 2018).

Under nutrition was defined as a Body Mass Index (BMI) below 18.5 kg/m^2 for adults(NCDBMILT18CREGv, 2016) and a BMI below the 5th percentile for age and sex for children. (Jan and Weir, 2021).

Well-nourished was defines as the Patients with a normal BMI range of 18.5 to 24.9 kg/m² have a balanced body weight and height, and 5th percentile to below 85th percentile for age and sex for children (Çakmur, 2023).

Successful treatment completion: Completion of the full course of anti-TB treatment resulting in bacteriological cure or significant clinical improvement as determined by healthcare providers(Borisov et al., 2019).

Unsuccessful treatment: a patient either experiences treatment failure (sputum smear or culture positive at 5 months or later during treatment), dies from TB or complications, or is lost to follow-up (treatment interrupted for two months or more) (Engoru et al., 2024).

3.10 Data Quality Control

Data quality was controlled through training of data collectors on objectives of study, and data collection procedures. There was daily data collection supervision by the principal investigator. The completeness and consistency of data were checked after data filled immediately before progressing to other data, both by data collectors and supervisor. Simple frequencies and cross-tabulation were done for outliers and improvable values and variables.

3.11 Data Processing And Analysis

Data were collected using the Kobo toolbox, cleaned for completeness, and exported to Excel, then to STATA version 17 for further data processing and analyses. Nutritional status was determined using baseline BMI which was classified as <18kg/m2 (under nutrition) and >=18& <=24 kg/m2 were well nourished in adults, and a BMI < 5th percentile and 5th percentile to < 85th percentile for age and sex for children were undernourished and well-nourished respectively. Then descriptive statistics were summarize patient characteristics and nutritional status, difference in treatment outcome were computed and compared among nourished and malnourished patients using proportion. Treatment outcome were categorized into treatment successful (cured and completed) and unsuccessful(Failure, Defaulters and Deaths). Logistic regression analysis was conducted to identify association between dependent and independent variables to explore the association between nutritional status and treatment outcomes. The study was used forward stepwise selection for variables. Multicollinearity was checked using Variance Inflation Factor (VIF) for all independent variables(confounding variables). Goodness of fit was also

checked by Hosmer and Lemshow statistics. Adjusted Odds Ratio with 95% confidence interval was used to report the strength of association and p-value <0.05 was used as cut-of point for significance of association.

3.12 Ethical Consideration

The ethical approval letter for the study was obtained from the Institutional Health Research Ethics Review Committee (IHRERC) of Haramaya University on reference number (IHRERC/106/2024). An official letter of agreement was obtained from Gardo TB center. A permission latter was obtained from head of hospital after the nature of the study was fully explained to them. Confidentiality of data was maintained throughout the research process by giving a code of records.

3.13 Plan For Dissemination Of The Study Findings

The findings will be disseminated through publication in a peer reviewed journal for the scientific community and presented at annual scientific meetings and conferences. A copy of the final report will also be submitted to the Gardo TB treatment center.

4. RESULTS

4.1 Socio-demographic Characteristics

A total of 250 under nutrition patients and 260 well-nutrition patients were included in the final analysis. Among the underweight group, two-third of them 172(68.8%) were males compared to 169 (65%)were well-nutrition patients. Among under nutrition patients, 29.2% were from rural areas and 70.8% from urban areas. The largest proportion in both groups were in the 20-39 years age range, with 32.8% under nutrition and 35.8% well-nourished, the least presented age-group was those over 60, with 14.8% under nutrition and 16.2% well-nourished, with mean age of the participants was 35.14 years, (SD ± 20.69).

Table 2: Socio demographic characteristics among patients on Anti-TB treatment Gardo, Puntland, Somalia (N=510)

Variables	**undernourished N=250**	**Well-nourished N= 260**	**Both groups N=510**
Sex			
Male	172(68.8%)	169 (65.0%)	341(66.9%)
Female	78 (31.2%)	91 (35.0%)	169(33.1%)
Residence			
Rural	73 (29.20%)	110 (42.30%)	183(35.9%)
Urban	177 (70.80%)	150 (57.70%)	372(64.1%)
Age of the patients			
<20 years	73(29.2%)	72 (27.7%)	145(28.4%)
20-39 years	82 (32.8%)	93 (35.8%)	175(34.3%)
40-59 years	58(23.2%)	53(20.4%)	111(21.8%)
>60 years	37 (14.8%)	42 (16.1%))	79(15.5%
Mean Age= 35.14 (SD ± 20.69).			

4.2 Clinical Characteristics Of patients

Overall, 437 patients (85.6%) had pulmonary tuberculosis, 209 patients (87.4%) under nutrition and 214 patients (83.5%) well-nourished patients, 73 patients (14.3%) had extra pulmonary tuberculosis, 41 patients (16.0%) and 32 patients (12.5%) are under nutrition and well-nourished respectively. Total of 3 patients (0.6%) have HIV, 2 (0.8%) patient are under nutrition, 1 (0.4 %) is well-nourished patients.(Table 3)

Table 3: Nutritional status, clinical characteristics among patients on Anti-TB treatment Gardo, Puntland, Somalia (N=510)

Variables	Under-nourished	Well-nourished	Both groups
Type of TB	**n1 250**	**n2 260**	**N 510**
Pulmonary	209 (87.5%)	214 (83.5%)	437(85.7%)
Extra pulmonary	41 (16.1%)	32 (12.5%)	73(14.3%)
Co-morbidities			
HIV status			
Positive	2 (0.8%)	1 (0.4%)	3(0.6%)
Negative	248(99.2%)	259 (99.6%)	507(99.4%)

4.3 TB Treatment Outcome

According to the distribution of treatment results, the Cured group accounted for 64.51% of all cases, while the Completed category represented 5.88%. Other categories were Default (11.57%), Failure (10.59%), and Dead (7.45%).

After combining as WHO standard, the Cured and Completed categories accounted for 70.39% of all treatment outcomes, suggesting that more than two-thirds of patients received a positive outcome(95% CI 66.2% - 74.2%). The proportion of successful treatment outcomes among patients with under nutrition And normal patients was 58.0% (95%CI 51.58%-63.7%) versus 82.3% (95%CI 78.5%-87.7%) respectively. Males had a higher percentage of successful treatment outcomes (72.1%) compared to females (66.9%), in the 20-39 age-group patients have better outcome than other age-groups and it was (77.7%), in the residence the urban residence patients have successful outcome than compared to the rural resident patients (70.6% vs. 69.9%).

Table 4: Treatment outcomes and baseline sociodemographic and clinical factors among patients on Anti-TB treatment Gardo, Puntland, Somalia (N=510)

Variables	Treatment outcome		Total (N)
	Successful treatment outcome	Unsuccessful treatment outcome	
Sex			
Female	113(66.9%)	56(33.1%)	169(33.1%)
Male	246(72.1%)	95(27.9%)	341(66.9%)
Age			
<20	112(77.2%)	33(22.8%)	145(28.4%)
20-39	136(77.7%)	39(22.3%)	175(34.3%)
40-59	75(67.6%)	36(32.4%)	111(21.8%)
>60	36(45.6%)	43(54.4%)	79(15.5%)
Residence			
Urban	231(70.6%)	96(29.4%)	327(64.1%)
Rural	128(69.9%)	55(30.0%)	183(35.9%)
Type of TB			
Pulmonary	308(70.5%)	129(29.5%)	437(85.7%)
Extra-pulmonary	51(69.9%%)	22(30.1%)	73(14.3%)
Nutritional status	145(58.0%)	105(42.0%)	250(49.0%)
Malnourished			
Well-nourished	214(82.3%)	46(17.7%)	260(50.1%)
HIV status			
Positive	1(0.3%)	2(1.3%)	3(0.6%)
Negative	358(99.7%)	149(98 .7%)	507(99.4%)

Nutritional Status With Treatment Outcome

The patients have well-nourished are better outcome than compared to those with under nutrition (82.31%vs58.00%)

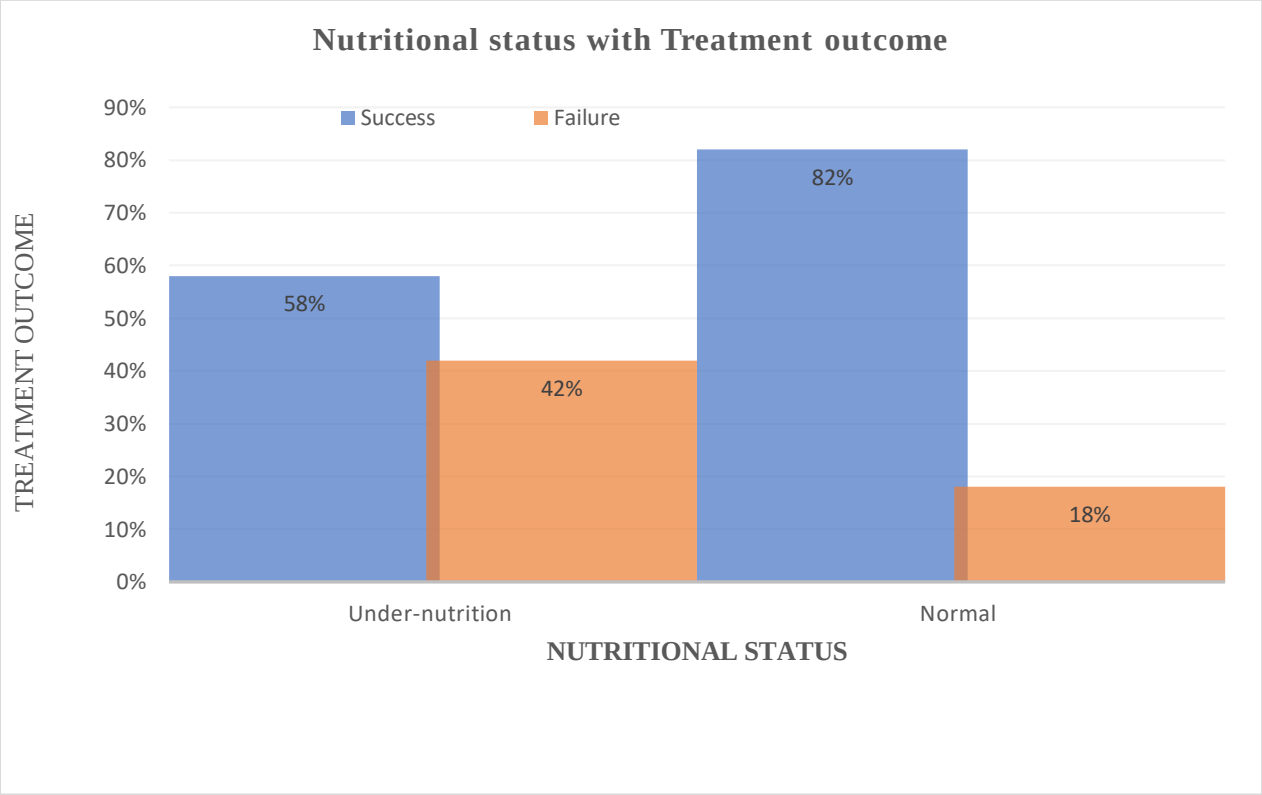

Figure 2 Nutritional status with treatment outcome among patients on Anti-TB treatment Gardo, Puntland, Somalia (N=510)

4.4 Association Of Nutritional Status With TB Treatment Outcome

In multivariate analysis, after adjusting confounding variables, the odds of patients with well-nourished were 4 times higher to develop treatment success compared those under nutrition group AOR=4.0 95%CI(2.4-6.5).

Table 5 Bivariate and multivariate analysis of factors associated with treatment outcome among patients on Anti-TB treatment Gardo, Puntland, Somalia (N=510)

Explanatory variables	Successful treatment outcome N(%)	Unsuccessful treatment outcome N(%)	COR(95%CI)	AOR(95%CI)	P-value
Age					
<20	112(77.24%)	33(22.76%)	4.0(2.24-7.30)	2.9(1.48-5.98)	0.002
20-39	136(77.71%)	39(22.29%)	4.1(2.35-5.35)	3.4(1.72-6.77)	0.000
40-59	75(67.57%)	36(32.43%)	2.4(1.37-4.51)	2.7(1.30-5.61)	0.008
>60	36(45.57%)	1.00	1.00	1.00	
Sex					
Male	246(72.14%)	95(27.86%)	1.2(0.86-1.91)	1.1(0.69-1.81)	0.628
Female	113(66.86%)	56(33.14%)	1.00	1.00	
HIV Status					
Positive	1(0.3%)	2(1.3%)	0.1(0.05-0.27)	0.09(0.03-0.2)	0.000
Negative	358(99.7%)	149(98.7%)	1.00	1.00	
Nutritional-status					
Well-nourished	214(82.31%)	46(17.69%)	3.62(2.4-5.4)	4.01(2.4-6.5)	**0.000**
Under nutrition	145(58.00%)	105(42.00%)	1.00	1.00	

COR= Crude Odd Ratio AOR= Adjusted Odd Ratio CI=Confidence Interval.

5. DISCUSSION

This study aims to assess the association between nutritional status and TB treatment outcome of the patients treated at the Gardo TB treatment center. Our findings indicate that more than two-thirds of patients (70.4%) had successful treatment outcomes, this study is lower than the rates found in other studies Pakistan, 94.2% (Laghari et al., 2018), Lagos, Nigeria (78.09%) (Oladimeji et al., 2021) ; Uganda 81.3% (Nansumba et al., 2018) ; Addis Ababa 90.13% (Sahile et al., 2021) ;Mizan-Aman Town overall treatment success rate was 75% (Simieneh et al., 2024) ; Harar 92.5% (Tola et al., 2019) ; and Motta Town, Northwest Ethiopia 88.4% (Limenh et al., 2024). One of the possible justifications might be due to difference between this and others may be due to under nutrition prevalence, HIV co-infection rates, medication adherence, and healthcare infrastructure across these settings.

Our study indicated that TB patients, 58% of undernourished patients have successful treatment outcomes, compared to 82.3% of well-nourished patients. This finding is consistent with previous studies showing that under nutrition adversely impacts TB treatment outcomes. For instance, a study conducted in Addis Ababa reported a treatment success rate of 85.3% for undernourished patients compared to 93.4% for the well-nourished group (Sahile et al., 2021). These findings indicated that under nutrition remains a significant barrier to successful TB treatment, with undernourished patients more likely to develop treatment failure.

The association between under nutrition and TB treatment outcomes can be explained by several biological mechanisms. Under nutrition has been shown to affect immunological function, thereby reducing the body's ability to generate an efficient immune response against Mycobacterium tuberculosis, the causative agent of TB. Patients with weakened immunity have a considerably reduced capacity to clear the infection, resulting in a longer disease course and greater risk of consequences, including treatment failure(Shah et al., 2024).

In our study, well-nourished patients had four times the likelihood of successful treatment outcomes compared to undernourished patients. This is compatible with the findings of the study conducted in Addis Ababa, it was found that the odds of successful outcomes were 2.42 times greater for normal patients compared to undernourished patients (AOR = 2.42 (95% CI 1.29-4.55)) (Sahile et al., 2021). While our

study shows a larger odds ratio, all other studies highlight the importance of dietary health in affecting TB treatment outcome; the research suggests that under nutrition considerably reduces the effectiveness of TB treatment outcome , emphasizing the need to treat nutritional deficiencies as part of TB management.

Furthermore, emerging research shows that nutritional status has substantial influence on TB treatment outcome. According a systematic review and meta-analysis in India (Anurag Bhargava et al., 2013), under nutrition, is substantially linked to failure treatment outcome. Similarly, a research done in Malaysia (Mokti et al., 2020) found that under nutrition tuberculosis patients had considerable lower odds of attaining success treatment outcome than those with normal nutritional status and also study in Indonesia (Putri et al., 2014), found that undernourished TB patients had considerably lower odds of successful treatment outcomes than well-nourished patients, underscoring the importance of nutritional deficiencies in the recovery process.

The effect of micronutrients in immune function is also crucial in TB treatment vitamins and mineral deficiencies such as Vitamin A, Iron and Zinc are common in under nutrition tuberculosis patients and can impede immunological responses, limit recovery and raise the chance of treatment failure. According to the studies the micronutrients supplementation can improve immune function, lower the occurrence of co-morbidities and increase treatment success rates in TB patients(Yang et al., 2025)

According to these studies, nutritional status plays vital role for success of TB treatment outcome under nutrition can be addressed by focusing treatments such as nutritional counseling,food support and vitamin supplementation, which might considerably improve TB patient outcomes. Nutritional interventions have been demonstrated to boost immunological responses, increase treatment adherence and lower the likelihood of problems including medication resistance (Shah et al., 2024). These interventions should be incorporated into normal TB care, particularly in high-burden areas where both tuberculosis and malnutrition are widespread.

5.1: Strength and limitation of the study

Strength of the study

The strengths of this study include that, it provides the opportunity of assessing nutritional status and TB treatment outcome of the patients treated in Gardo TB center.

Limitation of the study

The study may rely on existing medical records for patient data, which could have missing or incomplete information, leading to biases or limitations in the analysis.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This study demonstrates that substantial proportion of patients at center were undernourished during treatment. Moreover well-nourished patients have higher chance of success TB treatment outcomes. These finding indicate that nutritional status of patients is a key factor contributing to treatment outcomes in tuberculosis patients. Therefore, the integration of nutritional assessments and targeted interventions for under nutrition patients, especially those identifies at risk for under nutrition, should be prioritized within tuberculosis treatment frameworks to improve patient outcomes.

6.2 Recommendations

Based on the findings of this study regarding the significant impact of under nutrition on patient outcomes, the following recommendations can be made:

For Gardo health bureaus

Strengthen nutrition-focused strategies within TB programs by integrating routine nutritional screening and support into Anti-TB treatment protocols and allocate resources to ensure sustainable food and micronutrient support for undernourished patients.

For clinicians:

Clinicians should prioritize nutritional assessment for all TB patients, and actively address under nutrition through targeted interventions within TB treatment protocols. Integrating nutritional support will improve treatment response and patient outcomes.

For Future Researchers

This study would like to recommend future researchers conducting further investigations to identify additional influencing factors using different study designs, specifically, follow-up studies with primary data collection are encouraged to establish causal relationships and enhance the depth of findings .

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8. ANNEXES

8.1 Participants information sheet and informed voluntary consent form for head of center, medical doctors and also nursery

My name is Asia Mohamed Ahmed I am investigator for the study being conducted in this TB center, by my master degree at Haramaya University, college of medical and health science. I kindly request you to lend me your attention to explain to you about the study.

1. Study title

Assessment of nutritional status and treatment outcome among TB adult patients on Anti-TB treatment in Gardo TB treatment center in, Somalia, 2024.

2. Purpose/aim of the study

The purpose if this study is to conduct a thesis as partial requirement for fulfillment of master's program in Public Health Epidemiology for the principal investigator. To assess nutritional status and treatment outcome among TB adult patients on anti TB treatment Additionally, the findings will inform regional health bureaus in planning and implementing strategies of nutritional status and treatment outcome of the patients with Tuberculosis.

3. Procedure and duration

Data collectors will make medical record review for the registration of TB adult patients for the last two years that data id helpful for the study. A totally around sixteen questions and answers take from registration. And I will take the maximum of one hour.

4. Risks and benefits

The risk of taking data from register in the center is minimal, but we take data from record of the patients, there would not be any direct payment for participant of this study. But the findings from this research may reveal important information for TB treatment of the center.

5. Confidentiality

The information collected from this study will be kept confidentially and information about the patients which will be collected for this study will be stored in a file without patient's name. but the code number will be given to it. In addition, it will not be revealed to anyone except the principal investigator and will be kept at the locked key.

6. Rights

Participation of this study is entirely voluntary. You have the right to declare to allow or not the to be conducted in your center if you decide to allow the study you have the right to stop the study from being conducted at any time on behalf of the center management if any misdeeds and ethical procedure are observed in the premises of the center during the data collection this will not able you/your organization loss any benefit you are entitled.

7. Contact address

If there are questions or enquires anytime about the study or procedure, please contact us through the following address

Principal investigator: Asia Mohamed Ahmed cell phone: +252906458877

Email address asiyomohaahmed@gmail.com

Institutional Health Research Ethics Review Committee (IHREC): office phone:025-4662011 or asPo. Box: 235, Harar Ethiopia.

8. Declaration of informed voluntary consent

I have read the participant information sheet. I have clearly understood the purpose of the research, the procedures, the risks and benefits, issues of confidentiality, the rights of participating and the contact address for any queries. I have been given the opportunity to ask questions for things that may have been unclear. I was informed that participants have the right to withdraw from the study at any time or not to answer any question that they do not want. I am also informed that the Hospital has the right to stop this study from being conducted if any misdeeds and unethical procedures are observed during the data collection process in the Hospital's premises. Therefore, I declare my voluntary consent on behalf of Gardo TB center management to allow this study to be conducted in the Hospital with my initials (signature).

Name and Signature of Head of the Hospital: _____ Date _____

Name and Signature of the PI: _____ Date _____ **N.B**:

This is signed face to face in the presence of PI.

Thank you!

8.2 Medical record review

Part I : questions about sociodemographic factors

No	Question	Alternative choices for respondents
101	Sex	1. Male 2. Female
102	Age of the patient	_____ years
106	Place of residence	1. Urban 2. Rural
Part II : questions about clinical characteristics of the patients		
201	Site of TB infection	1. Pulmonary 2. Extra-pulmonary
Part IV: questions about Co-existing health conditions		
403	HIV status of the patient	1. Positive 2. Negative
Part IIV: question about nutritional status of the patient		

501	Nutritional status of the patient before treatment	1. Under-nutrition 2. Well-nutrition
Part IIIV: question about treatment outcome of the patient		
601	Treatment outcome of the patient	1. Successful (cured and completed) 2. Unsuccessful (death, failure and default)

8.3 CURRICULUM VITAE (CV)

PERSONAL INFORMATION

Name: ASIA MOHAMED AHMED.

DATE OF BIRTH : 2000

GENDER : FEMALE

MARITAL STATUS : SINGLE

RELIGION : ISLAM

NATIONALITY : SOMALI

EMAIL-ADRESS : asiyomohaahmed@gmail.com

CONTACT : + 252906458877

CITY : GARDO

LANGUAGES SPOKEN

- **ENGLISH** Fluent
- **SOMALI** Native
- **Arabic** Basic

Personal values

Collective wisdom: To enhance team spirit driven by the needs to look for solutions for the problems present

Integrity: Honoring of commitment, keeping promise and respecting contracts ability to do.

Innovation: always improving ways of doing things in order to improve efficiency

EDUCATION BACKGROUND

UNIVERSITY EDUCATION

Year: 2017-2021

UNIVERSITY: EAST AFRICA UNIVERSITY GARDO COMPUS

SECONDARY EDUCATION:

Year: 2013-2017

School: ALMUNTADA GARDO SECONDARY SCHOOL

PRIMARY EDUCATION:

Year: 2006-2013

School: DARALHUDA PRIMARY SCHOOL

RELEVENT WORKING EXPERIENCE

January 4TH 2019 --- 2ND November 2019: IMAN HOSPITAL

DESINATION: nursing

November 5TH 2019 --- 25TH Juley 2020: CARE HOSPITAL

DESINATION: nursing and pharmacy

August 6TH 2020--- 25TH May 2022: GEEL-XOOR SCHOOL

DESINATION: Science and English language teacher

RESEARCH AND ACADEMIC INTERESTS

- Epidemiology and Disease Surveillance
- Maternal and Child Health
- Community-Based Interventions
- Biostatistics and Data Analysis
- Public Health Education and Promotion

RESEARCH & DATA ANALYSIS SKILLS

- **Statistical Software**:
  - SPSS
  - STATA
  - Epi Info
- **Advanced Knowledge In**:
  - Biostatistics
  - Epidemiological Methods
  - Research Design & Implementation
  - Data Management and Interpretation

HOBBIES

- Reading and writing
- Socializing
- Making friend

REFERENCES

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