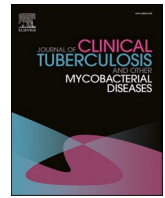




Contents lists available at ScienceDirect

Journal of Clinical Tuberculosis and Other Mycobacterial Diseases

journal homepage: www.elsevier.com/locate/jctube

Prevalence and associated factors of undernutrition among adult TB patients attending Amhara National Regional State hospitals, Northwest Ethiopia

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ARTICLE INFO

Keywords:

Tuberculosis
Undernutrition
Body mass index

ABSTRACT

Background: TB (tuberculosis) is an infectious disease affecting millions of people worldwide; globally, an estimated 10 million people developed TB disease in the past two years; and there were an estimated 1.4 million TB deaths. In Ethiopia, the burden of TB is ranked third and seventh in Africa and the world, respectively. Hence, studies are limited to solving many of the problems related to undernutrition. Therefore this study aimed to assess the prevalence and associated factors of undernutrition among adult TB patients attending Amhara National Regional State hospitals, Northwest Ethiopia.

Methods: A cross-sectional study was conducted in the TB clinics of Amhara Regional State Referral hospitals from March to April 2020. A total of 405 TB patients participated in the study. Proportional allocation and Systematic random sampling were employed to get representative study participants. The outcome variable, undernutrition, was determined by using Body Mass Index (BMI). Interviewer administered structured questionnaire, anthropometric measurements and patients' document review were done. Bivariable and multivariable logistic regressions were done to identify factors associated with undernutrition. Crude odds ratios (COR) and adjusted odds ratios (AOR) with 95% confidence intervals and P-values < 0.05 were employed to declare the significance and strength of association.

Results: The prevalence of under nutrition was 42.2% [95%CI: 32.8, 51.6]. The mean (\pm SD) BMI was 19.30 (\pm 2.83). The odds of undernutrition was higher among TB patients with poor wealth status [AOR = 2.39, 95%CI; 1.19, 4.79], alcohol consumption [AOR = 1.57; 95%CI, 1.01, 2.47], bedridden [AOR = 3.02, 95%CI; 1.21, 7.50] and ambulatory patient [AOR = 2.11, 95%CI; 1.36, 3.26]. Furthermore, being farmer [AOR = 2.59; 95% CI, 1.08, 6.20], housewife [AOR = 2.72; 95%CI, 1.22, 6.06] and unemployed [AOR = 2.46; 95%CI, 1.18, 5.13] were significantly associated with undernutrition.

Conclusion and recommendations: This study illustrated that a considerably high proportion of TB patients were undernourished in Amhara regionals state referral hospitals. Behavioral and socio-economic characteristics were significantly associated with undernutrition. Therefore, nutritional and social support activities are essential for TB patients, particularly those who are socio-economically disadvantaged. Regular nutritional screening and management, as well as behavioral interventions, should be strengthened.

1. Background

TB is an infectious disease affecting millions of people worldwide; globally, an estimated 10 million people developed TB disease in the

past two years; and there were an estimated 1.4 million TB deaths [1]. Of which 95% of the cases occur in developing countries [2]. TB is a significant public health concern of developing countries as it has been strongly associated with poverty and unsanitary living condition [2,3].

Abbreviations: AOR, Adjusted Odds ratio; COR, Crude Odds Ratio; DDS, Dietary Diversity Score; BMI, Body Mass Index; FANTA, Food and Nutrition Technical Assistance; HIV, Human Immune Deficiency Virus; SD, standard deviation; TB, Tuberculosis; WHO, World Health Organization.

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Available online 21 December 2021

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Most of the populations in developing countries are living in an unhealthy environment and with food insecurity which directly affects household food access, availability, and intake [2].

Inadequate food intake leads to poor nutritional status and impaired immune function. It was detected that there is a vicious cycle between undernutrition and TB, according to which poor nutritional status increases the risk of tuberculosis (TB) and in turn, TB can lead to undernutrition [4]. Both fat and fat-free mass reduction are common among TB patients [5–8] and this weakens T-lymphocyte-mediated immunologic defenses [9,10].

The risk of death is 2–4 folds higher among undernourished TB patients than well-nourished TB patients [5]. Globally about half (1 million) of TB patients suffer from undernutrition [11]. Cognizant of the burden of undernutrition, the World Health Organization (WHO) recommends all TB patients should be nutritionally assessed and treated with appropriate nutritional care [12]. Provision of an adequate balanced diet is associated with better weight gain and rapid sputum conversion [13]. Also, energy-dense supplements improved lean body mass and physical function [14].

TB-HIV co-infection poses an additional metabolic, physical, and nutritional burden, resulting in a further increase in energy expenditure, malabsorption, and micronutrient deficiency [12,15]. Because of such synergistic adverse effects, co-infected patients showed a marked wasting [15,16]. Furthermore, undernutrition patients were increased among TB-HIV co-infected patients, it is commonly observed in the case of TB-Diabetes Mellitus (DM) co-morbidity due to impaired cell-mediated immunity, renal failure, micronutrient deficiency, and pulmonary microangiopathy [17,18].

Behavioral factors are also associated with undernutrition, for instance, smoking amplifies the risk of undernutrition which might have been related to a reduction in appetite as well as increased resting energy expenditure mediated by the effects of nicotine on body metabolism [19,20]. Moreover, alcoholism and illicit drug use were found to exacerbate undernutrition among TB patients [12,21]. On the other hand, poor socioeconomic status, low educational status, being female, sputum smear-positive, unable to work functional status, and not receiving dietary counseling were a risk for undernutrition among TB patients [22–25].

Ethiopia is ranked third and seventh in Africa and the world, respectively, in terms of the burden of TB [26]. Surprisingly, TB is the eighth leading cause of hospital admissions and the third leading cause of hospital deaths in Ethiopia [27]. Besides, few studies demonstrated that considerable proportions of TB patients are undernourished [24,25]. Poor anti-TB treatment adherence has also been the commonest phenomenon among undernourished patients which might increase the risk of developing multi-drug resistant (MDR) type TB, one of the current challenging public problems in Ethiopia and the globe at large [12,28]. On the other hand, undernutrition is a strong predictor of active TB, suggesting that reduction in undernutrition in the general population could dramatically reduce the incidence of TB [29]. As a result, improving the nutritional status of TB patients has a pivotal role to reduce the unfavorable treatment outcome and reduce the risk of comorbidities and related mortality. Also, research showing the magnitude and determinants of undernutrition have paramount importance in enhancing early case detection and management; however, literature is limited in Ethiopia. Even the available researches are narrower in scope which ultimately affects the generalizability of the findings [24,25]. Similarly, these few studies did not examine the effect of dietary practice and food security, which are believed to be the immediate and underlying causes of undernutrition [24,25]. Therefore, this study aimed to investigate the prevalence and factors associated with undernutrition among adult TB patients in Amhara Region, Ethiopia.

2. Methods and materials

2.1. Study design, period, and setting

An institution-based cross-sectional study was conducted from March to April 2020 at TB clinics of Amhara Regional State Referral hospitals. Amhara regional state is located in northwest Ethiopia. In this region, there are 5 referral hospitals namely the University of Gondar comprehensive specialized hospital, Felegehiwot referral hospitals, Dessie referral hospitals, Debremarkos referral hospitals, and Deberbirhan referral hospitals, therefore the study was conducted in these hospitals. Each hospital serves as a referral center for more than five up to nine million people in their respective catchment areas. In each hospital, approximately 162 TB patients have been diagnosed and receive TB treatment per month.

2.2. Source and study population

All adult TB patients aged 18 and above attending TB clinics at Amhara Region Referral Hospitals were the source population. All TB patients attending at the time of the data collection period were the study population.

2.3. Inclusion and exclusion criteria

All TB patients attending at the time of the data collection period were included in the study. Patients who were unable to communicate, pregnant mothers, patients with mental disorders, and a patient who develop edema due to different disease disorders were excluded from the study.

2.4. Sampling size and sampling procedure

Sampling size was computed by using single population proportion formula considering the following assumptions; 39.7% as the prevalence of undernutrition among adults with TB in Addis Ababa [25]; 95% level of confidence and 5% margin of error. A 10% non-response rate was also added to get a minimum sample size of 405. Proportional allocation of samples was employed among each hospital; University of Gondar comprehensive specialized hospital (70 patients), Felegehiwot referral hospitals (85 patients), Dessie referral hospitals (59 patients), Debremarkos referral hospitals (72 patients), and Deberbirhan referral hospitals (119 patients), the average total population of TB patients attending in the five hospitals were 810 per a month; therefore the sample was selected every two patients intervals.

2.5. Data collection tools, procedures, and variable measurement

An interviewer-administered questionnaire was used to collect the socio-demographic, health, and nutritional characteristics of patients. Also, a chart review was carried out to ascertain HIV status, type of TB, duration of anti-TB treatment, and receiving supplements (vitamin B6 and Ready to Use Therapeutic Feeding). Functional status was assessed by interviewing participants on the level of assistance they require in carrying out daily activities. Accordingly, patients who did not require any special assistance to do their daily activities were categorized as 'Working', patients who were unable to care for themselves and require institutional or hospital care were considered as 'bed ridden' whereas patients who were unable to work, able to live at home and able to care for most of the personal needs and requires occasional assistance were considered as 'Ambulatory'. Dietary diversity was measured using the 24-h recall method and twelve food groups were used to summarize dietary intake as recommended by the Food and Nutrition Technical Assistance (FANTA) [30]. Finally, patients' dietary diversity was classified into low if patients' dietary diversity score was ≤ 3 food groups, medium when dietary diversity score was 4–5 food groups, and high

when dietary diversity score was ≥ 6 food groups [31].

Anthropometrical measurements were performed by a trained five BSc clinical nurses supervised by five BSc Health Officers. The weight of the study participants was measured using a beam balance to the nearest 0.1 Kg without shoes and all heavy clothing (e.g jackets, jerseys, belts, etc.) The weighing scale was also checked against a standard weight for its accuracy on daily basis. Calibration was performed before weighing each study participant by setting it to zero.

The height of the study participants was taken using a Seca vertical height scale standing upright in the middle of the board. Participants were asked to take off their shoes and stand in the Frankfurt plane (stand erect, and look straight in horizontal plain). The occipital (back of the head), shoulder blades, buttocks, and heels were touched measuring board, and height was recorded to the nearest 0.01 cm.

To determine undernutrition, the first Body mass index (BMI) among TB patients was computed by dividing weight in kilograms by the square of the height in meters (kg/m^2). Using BMI, undernutrition was defined by $\text{BMI} < 18.5 \text{ kg}/\text{m}^2$. Furthermore, undernutrition was stratified: severe ($\text{BMI} < 16 \text{ kg}/\text{m}^2$), moderate ($\text{BMI} 16\text{--}16.99 \text{ kg}/\text{m}^2$) and mild ($\text{BMI} 17\text{--}18.49 \text{ kg}/\text{m}^2$) [32]. Another variable, wealth status was computed based on the possession of household assets (i.e., refrigerator, sofa, bicycle, television, radio, and mobile telephone) was used as a proxy for the socioeconomic status [33] using principal component analysis. Finally, the wealth index was ranked into three; poor, medium, and high. To maintain the quality of data, the investigators and supervisors were carried out regular supervision, spot-checking, and reviewing the completed questionnaire on daily basis.

2.6. Data processing and analysis

The collected data were checked for completeness and consistency and then coded and entered in to Epi Info version 7 and exported to SPSS version 20 for analysis. Descriptive statistics like frequency, percentage, graphs, and tables were used for data presentation. The model fitness was checked by using the Hosmer-Lemeshow goodness of fit test with ($P = 0.77$). To run logistic regression analysis chi-square assumption was checked. The multicollinearity assumptions were also checked by using the variance inflation factor (VIF). Association between undernutrition and each categorical variable were assessed by using the Bivariable logistic regression P -value < 0.2 and then multivariable logistic regressions were employed to declare the significance and strength of association by using both crude odds ratios and adjusted odds ratios with 95% confidence intervals and P -values < 0.05 .

3. Results

3.1. Socio-demographic characteristics

A total of 405 adult TB patients participated in the study. The majority (42.3%) of the study samples were found between the age of 18–28 years with a mean (\pm SD) age of 33.75 ± 11.69 . Half of TB patients were married (54.6%) and illiterate (41.8%). Most (70.9%) of the samples were from the urban areas, while one-third (31.1%) had a private business (Table 1).

3.2. Dietary practice and household related characteristics

The majority of the study patients had no eating problem (64.4%). However, about three-fourth (78.5%) of TB patients had three or below meal frequency in the previous 24 h preceding the survey. Half (53.3%) and one-third (32.6%) of the study participants consumed alcohol and went without food and/or drink for a while, during fasting. Half of (53.1%) TB patients consumed food composed of high dietary diversity in the previous 24-hour preceding the date of survey, whereas (49.2%) TB patients were used piped into a yard or plot source of water (Table 2).

Table 1

Socio-demographic characteristics of adult TB patients in Amhara regional referral hospitals, Northwest Ethiopia 2020.

Characteristics	Frequency	Percentage (%)
Age		
18–28	171	42.3
29–38	115	28.4
39–48	71	17.5
>49	48	11.9
Sex		
Male	212	52.3
Female	193	47.7
Religion		
Orthodox	345	85.2
Muslim	46	11.34
Catholic	2	0.5
Protestant	12	3
Ethnicity		
Amhara	399	98.5
Oromo	3	0.7
Gurage	3	0.7
Residence		
Urban	287	70.9
Rural	118	29.1
Education		
Illiterate	169	41.8
Primary education (1–8)	76	18.8
Secondary education (9–12)	97	24
Above secondary education	63	15.6
Occupation		
Government employee	65	16
Private business	126	31.1
Farmer	75	18.5
Housewife	61	15.1
Unemployed [@]	78	19.3
Marital status		
Married	221	54.6
Unmarried	140	34.6
Divorce	30	7.4
Widowed	8	2
Family size		
≤ 4	308	76
> 4	97	24
Wealth status		
Poor	135	33.3
Medium	135	33.3
High	135	33.3

[@] Daily workers, students, had no works.

3.3. Health status and nutritional care-related characteristics

Among TB patients, the majority were HIV negative (75.3%), pulmonary negative (38.8%), and able to work (55.1%). More than three-fourth (85.9%) and two-third (65.2%) of TB patients were obtain nutritional counseling and vitamin B6 supplementation, respectively. Few of the study participants (1.7%) were living with at least one chronic illness such as (hypertension and diabetes) (Table 3).

3.4. Prevalence of undernutrition

The overall prevalence of undernutrition was 42.2% [95%CI: 32.8, 51.6]. Of which, 10.4%, 20.5%, and 11.30% were affected with severe, moderate, and mild undernutrition, respectively. The mean (\pm SD) BMI was 19.3 ± 2.83 (Fig. 1).

3.5. Factors associated with undernutrition

Variables like wealth status, alcohol consumption, working ability, occupation, and education were significantly associated with the outcome variable in the bivariable analysis. In the multivariable logistic regression analysis, wealth status, alcohol consumption, working ability, and occupation were significantly associated with undernutrition.

Table 2

Dietary practice and household characteristics of adult TB patients in Amhara regional referral hospitals, Northwest Ethiopia 2020.

Characteristics	Frequency	Percentage (%)
Food insecurity		
Yes	21	5.2
No	384	94.8
Dietary diversity		
Low	63	15.6
Medium	127	31.4
High	215	53.1
Meal frequency		
≤3	318	78.5
>3	87	21.5
Eating problem		
Yes	144	35.6
No	261	64.4
Going without food and/or drink for some time during fasting		
Yes	132	32.6
No	273	67.4
Taking animal or dairy products during fasting		
Yes	347	85.7
No	58	14.3
Availability of latrine		
Yes	369	91.1
No	36	8.9
Water source		
Piped into dwelling	82	20.2
Piped into yard or plot	201	49.2
Public tap/standpipe	76	18.8
Tube well/borehole	25	6.2
Protected well	5	1.2
Unprotected spring	16	3.7
Water treatment		
Yes	58	14.3
No	347	85.7
Currently alcohol consumption		
Yes	216	53.3
No	189	46.7

The odds of undernutrition were 2.39 times higher among TB patients with poor wealth status than high wealth status [AOR = 2.39, 95% CI; 1.19, 4.79]. TB patients who consumed alcohol were 1.57 times more likely undernutrition than patients who did not consume alcohol [AOR = 1.57; 95%CI, 1.01, 2.47]. The odds of undernutrition were 3.02 times [AOR = 3.02, 95%CI; 1.21, 7.50] and 2.11 times [AOR = 2.11, 95%CI; 1.36, 3.26] higher among bedridden and ambulatory patients than patients who could work respectively. Moreover, being a farmer was 2.59 times [AOR = 2.59;95%CI,1.08,6.20], being a housewife was 2.72 times [AOR = 2.72;95%CI,1.22,6.06] and being unemployed was 2.46 times [AOR = 2.46;95%CI,1.18,5.13] more likely undernutrition than patients who were employed in government sector respectively (Table 4).

4. Discussion

The study showed that 42.2% [95%CI: 32.8, 51.6] of adult TB patients were undernourished; this finding was consistent with the studies done in Ethiopia, Addis Ababa (39.7 %) [25], and the study done in Ghana (51%) [21].

Accordingly, this finding was slightly lower than the study done in Ethiopia, Adama Town (53%) [23]; the possible reasons could be the tool we used and the sample size matters the difference.

In this study, bedridden TB patients were 3.02 times and ambulating patients 2.11 times more likely undernutrition than TB patients who were able to work. The possible reasons could be the risk of wasting is higher as their functional status decreased due to impaired mobility as well as TB infection and other co-morbidities [15,16,25].

The other finding of this study illustrated that alcohol consumed TB patients were 1.57 times more likely undernutrition than patients who

Table 3

Health status, Nutritional care and support of adult TB patients in Amhara Regional referral hospitals Northwest Ethiopia 2020.

Category	Frequency	Percentage (%)
HIV status		
Positive	47	11.6
Negative	305	75.3
Unknown	53	13.1
Ability to work		
Working	223	55.1
Ambulatory	158	39
Bedridden	24	5.6
Type of TB		
Sputum positive pulmonary TB	84	20.7
Sputum negative pulmonary TB	157	38.8
Extrapulmonary TB	148	36.5
MDR TB	16	4.0
Duration on anti-TB		
0-2 months	223	55.1
2-6 months	182	44.9
Vitamin B6 supplement		
Yes	264	65.2
No	141	34.8
Chronic illness [#]		
Yes	7	1.7
Other health problems in the previous one month [§]		
No	277	68.4
Yes	128	31.6
Plum pinnate supplement		
Yes	110	27.2
No	295	72.8
Organization aid/support		
Yes	29	7.2
No	376	92.8
Nutritional advice		
Yes	348	85.9
No	57	14.1

Notes: The supper script indicates; [#] Hypertension, Diabetes mellitus; [§] Poor appetite, Nausea, Vomiting, Difficulty of swallowing.

never took alcohol. The possible reason could be, excess consumption of alcohol damages the gastric mucosa and causes malabsorption; especially this problem worsens among TB patients and leads to undernutrition [34]. However, Alcohol provides calories to our body but it interferes with the body's growth, maintenance, repair, and recovery from illness [35,36].

Also, the likelihood of undernutrition was increased by more than twofold among TB patients in the poor wealth category. This finding is congruent with the study done in Ghana [21]. Patients with poor socioeconomic status might not afford nutrient-dense and protein-rich food, as a result, a cereal-based monotonous diet is common in this group of people which again diminishes their body ability to counteract excessive TB-associated fat and fat-free loss [6,37].

Patients who were unemployed 2.59 times, housewives 2.59 times, and farmers' 2.59 times more likely undernutrition than governmental employed TB patients. The possible reason could be unemployed TB patients were easily challenged with income generation due to their existing health problems. Similarly, in Ethiopia most of the home tasks are relatively covered by women's this substantial workload on TB patients may contribute to undernutrition [38]. Farming or agricultural activities contribute to the welfare of households in two ways, for food security and it provides income [39]. Despite, TB infected farmers may have a problem with their daily farming activity subsequently the farming production becomes decreased which may contribute to undernutrition [40].

4.1. Strength and limitation of the study

This study addressed an important public health concern, undernutrition, in a wider geographical area among TB patients where little is

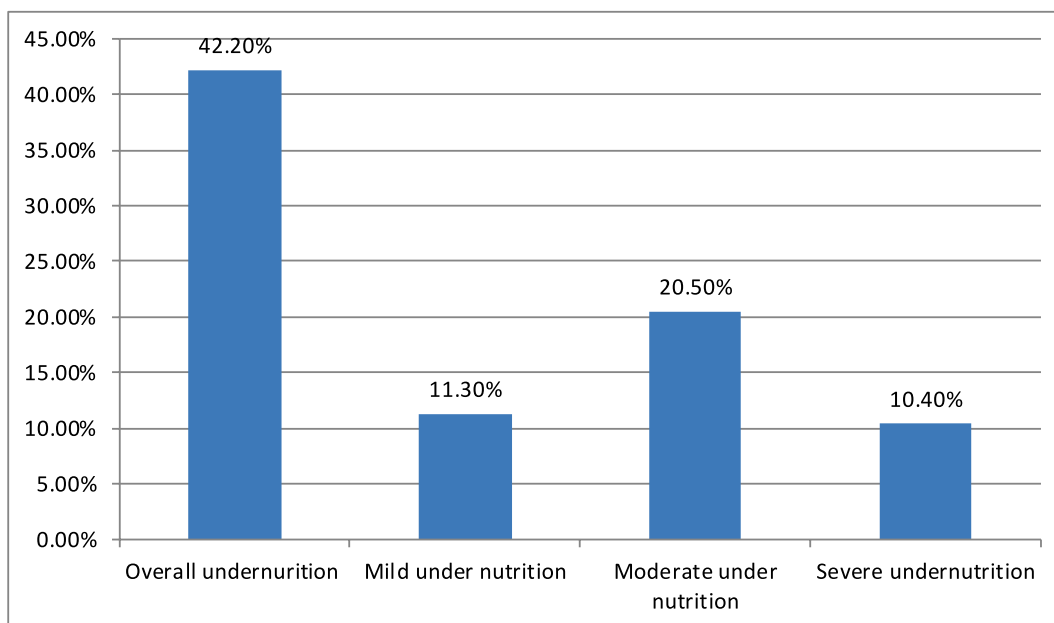


Fig. 1. Prevalence of undernutrition among TB patients in Amhara Region referral hospitals, Northwest Ethiopia 2020.

Table 4

Factors associated with undernutrition among adult TB patients in Amhara Regional referral hospitals, Northwest Ethiopia 2020.

Variables	Undernutrition		COR (95%CI)	AOR (95%CI)
	Yes	No		
Occupation				
Government employee	46	19	1.00	1.00
Private business	50	76	3.68(0.85,3.30)	1.45(0.74,2.83)
Farmer	28	47	4.06(0.57,2.43)	2.59(1.08,6.20)**
Housewife	29	32	2.67(1.21,4.92)	2.72(1.22,6.06)**
Unemployed	45	33	1.77(1.16,4.43)	2.46(1.18,5.13)**
Ability of work				
Working	150	73	1.00	1.00
Ambulatory	75	83	2.27(1.49,3.45)	2.11(1.36,3.26)**
Bed ridden	9	15	3.42(1.43,8.19)	3.02(1.21,7.50)**
Wealth status				
Low	70	65	2.38(1.49,3.45)	2.39(1.19,4.79)**
Medium	59	76	1.72(1.04,2.83)	1.78(0.95,3.33)
High	42	93	1.00	1.00
Alcohol consumption				
Yes	106	110	1.83(1.23,2.74)	1.57(1.01,2.47)**
No	65	124	1.00	1.00
Education				
Illiterate	40	55	1.68(0.85,3.31)	1.25(0.44,3.05)
Read and write	25	49	1.18(0.57,2.43)	0.94(0.33,2.64)
Primary	39	37	2.44(1.21,4.92)	1.44(0.54,3.87)
Secondary	48	49	2.27(1.16,4.43)	1.66(0.68,4.04)
Diploma and higher	19	44	1.00	1.00
Meal frequency				
<3	141	177	1.51(0.92,2.48)	1.48(0.90,2.43)
≥3	30	57	1.00	1.00
Family size				
<4	136	172	1.00	1.00
≥4	35	62	1.40(0.45,1.14)	0.73(0.45,1.18)

** Statistically Significant at p value < 0.05.

known about it before. However, the cross-sectional nature of this study could not show the causal relationship between the response and explanatory variables. Hence the study included samples from facilities; the findings may not be generalizable to those who did not attend the hospitals. Moreover, the study is not free from recall bias as the measurement of dietary diversity was relied on memory, nevertheless, efforts, such as training of data collectors and supervisors and appropriate probing techniques were used to minimize this bias.

5. Conclusion and recommendations

This study showed a considerably high proportion of TB patients were undernourished in Amhara Regional State. Behavioral and socio-economic characteristics were significantly associated with undernutrition. Therefore, nutritional and social support activities are essential for TB patients, particularly those who are socio-economically disadvantaged. In addition, regular nutritional screening and management, as well as behavioral interventions, should be strengthened as a pillar component of therapeutic interventions.

6. Ethics approval and consent to participate

Before data collection, ethical approval was obtained from the Institutional Review Board of the University of Gondar. Permission letter was also obtained from Amhara Regional Health Bureau and each Referral Hospital administrators. Written consent was taken from each study participant after the purpose of the study had been explained. They were informed to withdraw at any time and/or to refrain from responding to questions. Study participants were also informed that all the data obtained from them would be kept confidential using codes instead of any personal identifiers.

Funding

This work was supported by the University of Gondar.

CRediT authorship contribution statement

Kidist Endalkachew: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Yohannes Mulu Ferede:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Terefe Derso:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft,

Writing – review & editing. **Adane Kebede:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

The authors acknowledge the University of Gondar for funding this study and also the authors acknowledge the study participants, data collectors, and all health professionals working in TB clinics in Amhara region hospitals.

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