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Under-nutrition among adult tuberculosis patients completing intensive-phase treatment at public health facilities in Kembata Zone, Central Ethiopia Region

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Abstract

Background Nutritional impacts of tuberculosis (TB) have long been recognised. According to the national TB treatment guidelines, individuals with TB are assessed for under-nutrition during treatment initiation and receive regular nutritional counselling and support, including food supplementation, when the condition is detected. However, the extent of under-nutrition after completing intensive-phase of treatment, which may indicate its potential persistence, remains unclear especially in resource-limited settings.

Objective This study aimed to assess the extent of under-nutrition and associated factors among adult TB patients completing intensive-phase treatment at public health facilities of Kembata Zone, Central Ethiopia Region.

Methods We conducted a cross sectional facility-based study among 334 adult TB patients in the continuous-phase treatment. Participants were recruited using a cluster sampling technique. Bivariate logistic regression analysis was performed to assess the association between under-nutrition and explanatory variables. Odds ratios along with 95% confidence interval (CI) were estimated to identify factors significantly associated with under-nutrition using multivariable logistic regression analysis. The level of statistical significance was determined at P-value less than 0.05.

Results Under-nutrition was detected in almost 19% of participants. Sociodemographic and clinical factors contributed to the presence of under-nutrition in the continuous-phase of treatment. Not attending formal education (AOR: 4.2; 95%CI: 1.7–10.4) and living in a family of more than five (AOR: 2.3; 95%CI: 1.2–4.6) were sociodemogrphic factors associated with the occurrence of under-nutrition. Having extra-pulmonary TB (EPTB) (AOR: 3.2; 95%CI: 1.4–7.6) and shorter length (less than four months) of treatment (AOR: 4.3; 95%CI: 1.9–9.5) were clinical conditions linked with under-nutrition.

Conclusions Our study identified a higher prevalence of under-nutrition in the continuous-phase of TB treatment than the targets of clinical guidelines, which expect optimal nutritional status in all patients. This may suggest potential persistence of poor nutritional status (or a lack of weight gain) from the earlier period of treatment. This may reflect lower understandings of the nutritional impact of TB in association with a lack of formal education, and a

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limited adequate diet due to a larger family size. Being in the earlier period of continuous-phase treatment and having EPTB also increased the likelihood of under-nutrition. Continuous monitoring and support is suggested throughout the treatment course with a particular focus on individuals with a lower socioeconomic background and EPTB.

Keywords Under-nutrition, Continuous-phase of TB treatment, Associated factors, Kembata zone, Central ethiopia region

Background

Malnutrition and tuberculosis (TB) are important public health problems in the developing regions of the world [1]. Both problems are highly interrelated, one compounding the effect of the other. Under-nourished individuals can have immune deficiency leading to the development of active TB and a greater severity of the infection. They are less likely to have successful treatment outcomes with an increased risk of relapse and death [1, 2]. Research shows that more than a quarter of all TB cases in 22 high-burden countries are attributable to under-nutrition [3]. Further, individuals with active TB often experience loss of appetite and altered metabolism leading to wasting [1, 4].

The nutritional status of individuals with TB may vary depending upon phases of the treatment course. For example, lower nutritional status during initiation into TB treatment is expected to improve as treatment progresses, becoming better in the later phases of the treatment [5]. While weight gain of 5% or more is the main indicator of treatment success, individuals who fail to gain, or continue to lose, body weight after the first two months of treatment are less likely to achieve successful treatment outcomes when they complete the course [5]. The risk of further complications including death is also influenced by this lack of weight gain following treatment initiation [6].

Although no published studies have specifically focused on nutritional status during the continuous-phase of treatment, findings of studies assessing the issue irrespectively of the treatment phase show a significant contextual variation. Higher prevalence estimates for under-nutrition have been reported in sub-Saharan African (SSA) countries [7, 8] compared to developing countries in other regions [9]. Similar variation has also been observed in Ethiopia with the prevalence of under-nutrition during the continuous-phase ranging from 13% in southern Ethiopia [10] to 33% in eastern Ethiopia [11].

Socioeconomic, behavioural and clinical factors have been found to be associated with under-nutrition in people undergoing TB treatment in general. People who are from households with low income are at an increased risk of developing under-nutrition [12, 13]. Circumstances such as unemployment, family size and food insecurity are strongly associated with under-nutrition risk [11, 14, 15]. Literacy status and gender have been linked with the occurrence of under-nutrition during TB infection, where less educated individuals and females are more likely to be undernourished [6, 16–18]. Individual risk behaviours such as substance abuse also increase the risk [18, 19]. There is strong evidence that HIV/TB co-infection increases the likelihood of under-nutrition, shown to increase the risk by multiple times relative to TB monoinfection in some settings [10, 17, 20, 21]. Other clinical conditions associated with reduced body function have also been associated with under-nutrition [22].

It is unclear, however, whether the above-described and other factors can contribute to the occurrence of under-nutrition following the intensive-phase of treatment – i.e., after TB patients are assessed for the presence of the condition and receive regular nutritional counselling and support including food supplementation, according to the national TB treatment guidelines [23]. We aimed to assess the extent of under-nutrition and associated factors among adult TB patients in the continuous-phase treatment in Central Ethiopian Region health facilities. Our findings could inform the development of targeted intervention strategies to address the impacts of under-nutrition on TB treatment success, especially in resource limited settings.

Methods

Study design and setting

We conducted a cross-sectional study from October to December 2023 among adults (aged 18 years or above) who were on TB treatment at selected public health facilities of Kembata Zone, Central Ethiopia Region. The study encompassed seven health centres and three hospitals out of 30 health centres and four hospitals (three primary and one general hospital) present in the jurisdiction.

Sample size determination

The minimum sample size required for this study was estimated using a two-population proportion formula [24] considering various assumptions such as: equal number of individuals in exposed and non-exposed groups (1:1 ratio) with respect to length of time on treatment as this yielded the largest sample size compared to other factors (with a proportion of 63% under-nutrition in patients staying four months or less and 40% in those staying longer and odds ratio of 2.18, according to previous research) [11]; and 95% two-sided confidence level, 5% margin of error, 80% power, 1.5 for adjusting

clustering effect (see below) and 10% non-response rate. Accordingly, 357 participants were required to determine factors associated with under-nutrition during continuous-phase of TB treatment.

Sampling technique

Participants were selected using a cluster sampling technique, which involved inclusion of all eligible TB patients in the selected health facilities. While the health centres and primary hospitals were randomly selected using a lottery method, the general hospital (i.e. Dr Bogalech Gebre General Hospital) was purposively chosen because of larger number of TB patients and possible difference in the nature of care. TB patients were eligible if they were on treatment for at least two months (i.e. completion of intensive-phase) [23]. Accordingly, of 504 TB patients on treatment at the health facilities when the study started, 240 were in the continuous-phase (already had taken treatment for more than two months). Individuals who were in the intensive-phase of treatment at the study commencement were also subsequently recruited when they entered into the continuous-phase until the required sample size reached. However, pregnant women and those with multi-drug resistant (MDR)-TB and/or treated for longer than six months were excluded because of their possible unique nutritional requirements. History of last menstruation was sought to rule out the presence of pregnancy in female participants. Patients who were critically ill and unable to communicate were also excluded as they could neither adequately provide the required information nor informed consent.

Data collection and measurement

Health professionals working in TB clinics were trained by the research team to undertake interviewing and anthropometric measurements of participants during their regular clinic visit. The interviewing was carried out using a structured-questionnaire developed based on a review of literature related to under-nutrition and TB (see Supplementary file). The questionnaire encompassed information related to socioeconomic, behavioural and nutritional characteristics as well as health care services. The socioeconomic questions included information on demographic and economic background whereas the behavioural component focused on substance abuse and engagement in a regular physical activity.

The nutritional data gathered included information about household food security, and the extent of delay in TB diagnosis, treatment interruption, the presence of other medical conditions and nutritional counselling and support (including food supplementation) were covered under the health care services component of the questionnaire. We also reviewed treatment log books to retrieve data related to category of treatment (new or re-treatment), HIV status, type of TB (pulmonary or extra pulmonary) and duration of treatment.

The questionnaire was originally formulated in English and then translated in to Amharic for participants who could understand the language. Interviewers orally translated into other local languages such as Kambatisa for those who had a limited fluency in Amharic. The questionnaire was pre-tested at two health care facilities not part of the main study and corrections were made to maintain clarity and consistency. The principal investigator (RAD) regularly monitored of the overall data collection process and checked the completed questionnaire for consistency and completeness before making data entry.

Measurements

Body mass index (BMI) measurement was used to determine nutritional status. This was calculated as the weight of an individual in kilograms divided by the same individual's height in metres squared. Weight was measured with minimal or light clothing on with the measuring scale continuously calibrated to zero after each measurement. Height was measured at standing position without shoes. Both height and weight measurements were recorded to two decimal places. Participants were categorised as having under-nutrition when their BMI value was less than 18.5 kg/m^2 and normal when it was 18.5 kg/m^2 or above as recommended by the international guidelines [25].

We measured household food security status using the Household Food Insecurity Access Scale (HFIAS) [26]. The scale has nine questions with each question asking about occurrence and frequency of occurrence. Each frequency question weighs from one to three scores giving a total score of 27. A total score of 18 or above represented the presence of food insecurity in the household. A delay in TB diagnosis was determined by taking into account both patient delay and health system delay. Patient delay was defined as a period of more than 30 days from the onset of the first symptom of suspected TB to the date when the patients first contacted any health care facility whereas health system delay was a period more than seven days from the date of patients' first contact with any health care facility to the date of final diagnosis [27].

Data analysis

Data were computerised using EpiData version 3.1 and exported to Statistical Package for Social Science (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). Descriptive statistics, including mean and frequency, were computed to summarise data. Binary logistic regression analyses were undertaken to identify associations between the presence of under-nutrition and explanatory variables. To

Table 1 Socio-economic and demographic characteristics of adult TB patients completing intensive-phase treatment in Kembata Zone public health care facilities, Central Ethiopia Region, 2024 ($n=334$)

Variable		Frequency (*n*)	Percent (%)
Gender	Male	187	56.0
	Female	147	44.0
Age	18–27	106	31.7
	28–37	105	31.4
	38–47	61	18.3
	>48	62	18.6
Partner status	Have partner	225	67.4
	Have no partner	109	32.6
Occupation	Student	34	10.2
	Daily labourer	43	12.9
	Merchant	49	14.7
	Government employee	57	17.1
	Unpaid domestic duties	75	22.4
	Farmer	76	22.7
Education	No formal education	159	47.6
	Formal education	175	52.4
Family size	≤5	155	46.4
	>5	179	53.6
Average monthly income in ETB	<2000	77	23.0
	2000–3000	236	70.7
	>3000	21	6.3

Family size represents the total number of people living in the same household; Average monthly income indicates an estimate by the participant

ETB: Ethiopian Birr

Table 2 Behavioural and dietary characteristics of adult TB patients completing intensive-phase treatment in Kembata Zone public health care facilities, Central Ethiopia Region, 2024 ($n=334$)

Variable		Frequency (*n*)	Percent (%)
Cigarette smoking	Yes	15	4.5
	No	318	95.2
Alcohol use	Yes	20	6.0
	No	314	94.0
Khat chewing	Yes	23	6.9
	No	311	93.1
Engagement in physical exercise	Yes	162	48.5
	No	115	34.5
Frequency of physical exercise in a week (in days)	1–3	1	3
	≥4	15	4.5
Nutritional counseling	Yes	302	90.4
	No	32	9.6
Eating problem	Yes	26	7.8
	No	308	92.2
Food security	Secure	132	39.5
	Insecure	202	60.5

reduce the likelihood of missing biologically plausible relationships by excluding statistically weaker associations, variables associated with a P-value of less than 0.25 in the bivariate analysis were candidates for multivariable logistic regression analysis. In the multivariable analysis, variables with a P-value of less than 0.05 were considered to have a statistically significant association with under-nutrition. A co-linearity diagnostic was conducted by estimating a variance inflation factor (VIF), which showed non co-linearity between covariates (VIF = 1.1). Model fitness was checked by using Hosmer–Lemeshow goodness-of-fit test [28] and data fit the model well (P >0.05). Adjusted odds ratio (AOR) with 95% confidence interval was estimated to show the strength of associations.

Results

Socio-demographic characteristics

Of 357 potential participants present in the health care facilities, 334 agreed to participate in the study, making a response rate 94%. The mean age of participants was 35 (± 11.8) years with a minimum age of 18 and maximum of 70 years. More than half (56%) of participants were male. Most participants (58%) were rural residents and married in their marital status (67%). Slightly more than half (52%) of them attended some kind of formal education and almost similar percentage (54%) reported living with more than five family members. Farming (23%) and engagement in unpaid domestic duties (22%) were the most common types of occupations with the majority of participants (71%) having an average monthly income between 2000 and 3000 Ethiopian Birr (ETB), which was lower than the average monthly income of the general population in the zone (5905ETB) [29]. The socio-economic and demographic characteristics of participants are summarised in Table 1.

Behavioral and dietary characteristics

Small proportions of participants reported current smoking of cigarette (5%), consuming alcohol (6%) or chewing khat (7%). Almost half (49%) reported not engaging in any physical exercise while one third (34%) reported engaging in physical exercise for one to three days per week. Although the majority (90%) of participants reported having received nutritional counselling and were found to have no eating problems (92%), most (61%) had food insecurity issues (see Table 2 below).

Clinical characteristics and nutritional status

With regard to type of TB, 87% of the participants had pulmonary TB and the majority (97%) were new patients. Twelve (4%) participants reported coinfection with HIV and 28% reported other comorbidities, the most common

of which were gastritis (36%) and renal diseases (29%). Regarding timely diagnosis of TB, 45% had a patient delay and 10% with health system delay leading to an overall delay of 11%. For most participants (62%), the length of treatment was within the range of one to four months. Under-nutrition was detected in almost 19% of the participants (see Table 3 below).

Factors associated with under-nutrition

Among covariates which were found to be candidates for multivariable analysis, socioeconomic and clinical factors were associated with the presence of under-nutrition following intensive-phase of treatment as presented in Table 4 below. Accordingly, the odds of not attending formal education in individuals with under-nutrition were more than fourfold the odds of those without under-nutrition (AOR: 4.2; 95%CI: 1.7–10.4). The odds of living in a family of more than five in those with under-nutrition were more than double those without under-nutrition (AOR: 2.3; 95%CI: 1.2–4.6). Relative to those without under-nutrition, individuals with under-nutrition had more than three times the odds of having extra-pulmonary TB (EPTB) as opposed to pulmonary TB (AOR: 3.2; 95%CI: 1.4–7.6). Similarly, relative to individuals without under-nutrition, those with under-nutrition had more than four times the odds of having used TB treatment for less than four months (AOR: 4.3; 95%CI: 1.9–9.5).

Table 3 Clinical characteristics and nutritional status of adult TB patients completing intensive-phase treatment in Kembata Zone public health care facilities, Central Ethiopia Region, 2024 ($n=334$)

Variable		Frequency (*n*)	Percent (%)
Type of TB	PTB	290	86.8
	EPTB	44	13.2
Length of treatment (in months)	≤4	210	62.9
	>4	124	37.1
Category of treatment	New	324	97.0
	Retreatment	10	3.0
HIV status	Positive	12	3.6
	Negative	322	96.4
Co-morbidity	Yes	113	27.8
	No	221	72.2
Type of co-morbidity ($n=113$)	Diabetes mellitus	3	2.6
	Hypertension	10	8.9
	Renal disease	33	29.2
	Gastritis	41	36.3
	Other	26	23.0
Patient delay	Yes	135	44.9
	No	199	59.6
Health system delay	Yes	33	9.9
	No	301	90.1
Total diagnostic delay	Yes	37	11.1
	No	297	88.9
Nutritional status	Undernourished	62	18.6
	Normal	272	81.4

"Other" under the type of comorbidity indicates malaria and other acute febrile illnesses

EPTB: Extra-pulmonary tuberculosis; *PTB:* Pulmonary tuberculosis: *TB:* Tuberculosis

Discussion

This study assessed occurrence of under-nutrition among adult TB patients in a resource-limited setting after completion of intensive-phase of treatment - a period during which the poor nutritional status associated with the infection often exists and the national TB treatment guidelines recommend provision of nutritional supports including food supplementation [23]. Our study revealed that almost 19% of TB patients in the study area had under-nutrition during the continuous-phase of treatment, which may also suggest potential persistence of earlier poor nutritional status. This prevalence is considered to be high given the aim of the clinical guidelines to cure (or ensure weight gain) all TB-related under-nutrition at the end of the intensive-phase [23]. The finding also supports previous findings which show the presence of a higher prevalence than expected during continuous-phase of treatment in Ethiopia [10, 11].

Several factors appeared to contribute to the occurrence of under-nutrition in the continuous-phase of TB treatment. One of these is a lack of formal education which was increased by fourfold in those with under-nutrition. Attending formal education has previously been identified as an important influencing factor of nutritional status among TB patients on treatment in low-income countries [6, 8, 17]. Having a formal education could play a role in enhancing awareness of the nutritional consequences of TB and hence the importance of adequate nutrition along with treatment. It could also be associated with the possibility that people with formal education are more likely to have better income, which increases financial ability to meet nutritional requirements when dealing with TB. Nonetheless, the influence of income seems to be attenuated in this study as the majority of participants fell under the lower income categories.

A related sociodemogrphic factor associated with the presence of under-nutrition during continuous-phase of treatment was a larger family size. Although food insecurity and household income have not been found to be significant factors in our analysis, the observed influence of family size implicitly highlights the important adverse effect of inadequate diet in the study population, which might have been diluted by the overall high prevalence (i.e. 61%). It would seem intuitive that low incomes in the face of large family size may lead to food insufficiency, which in turn resulting in nutritional deficiency

Table 4 Factors associated with under-nutrition among adult TB patients completing intensive-phase treatment at public health care facilities of Kembata Zone, Central Ethiopia Region, 2024 ($n=334$)

Variable		Under-nutrition		COR (95%CI)	AOR (95%CI)
		Yes	No		
Gender	Male	28	159	1	1
	Female	34	113	1.71(0.98–2.98)	1.23(0.64–2.37)
Education	No formal education	47	112	4.48(2.39–8.40)	4.23(1.71–10.45)*
	Formal education	15	160	1	1
Residence	Rural	44	145	2.14(1.18–3.89)	1.18(0.54–2.61)
	Urban	18	127	1	1
Family size	≤5	19	136	2.26(1.26–4.08)	2.36(1.21–4.61)*
	>5	43	136	1	1
Average monthly income in ETB	<2000	28	49	5.43(1.176–25.050)	4.61(0.73–29.02)
	2000–3000	32	204	1.490(0.331–6.705)	1.40(0.26–7.66)
	>3000	2	19	1	1
Food security status	Secure	16	116	1	1
	Insecure	46	156	2.14(1.15–3.96)	1.64(0.66–4.04)
Type of TB	PTB	49	241	1	1
	EPTB	13	31	2.06(1.01–4.22)	3.19(1.34–7.61)*
Length of treatment (in months)	≤4	52	158	3.75(1.83–7.70)	4.30(1.96–9.45)*
	>4	10	114	1	1
HIV status	Positive	4	8	2.28(0.66–7.81)	2.86(0.68–12.08)
	Negative	58	264	1	1

EPTB: Extra-pulmonary tuberculosi;: *PTB:* Pulmonary tuberculosis; *TB:* Tuberculosis

*Significant association at $P<0.05$

especially among those with diseases of high nutritional consequences such as TB. Moreover, households with a larger family size use different strategies to cope with food insecurity such as reducing number and frequency of meals, reliance on less expensive (nutritive) food and restricting consumption of adults to prioritise children [30, 31], all of which affect the nutritional status of vulnerable individuals. Many studies previously emphasised the important influence of these socioeconomic factors on the nutritional status of people with TB in low-income countries [8, 10, 13, 32], suggesting the need for continuous monitoring and handling of the condition among such groups throughout the treatment course. There is also evidence that long term nutritional support results in a greater weight gain especially in those with earlier severe under-nutrition [33].

Under-nutrition was also associated with length of continuous-phase treatment and the presence of extra-pulmonary TB (EPTB). Individuals who were on the earlier period of continuous-phase treatment were more likely to have under-nutrition. This might be related to possible residual effects of poor nutritional status existed during treatment initiation or later in intensive-phase of treatment. A shift in medication regimen in association with entry into the continuous-phase might also cause a new episode or persistence of existing under-nutrition as there is only a limited time for acquaintance with the new regimen [23]. On the other hand, consistent with previous reports [18, 34], individuals with EPTB had a higher likelihood of under-nutrition. EPTB is often associated with delay in the detection of the disease and represents a complicated form of TB resulting in an exacerbated depletion of nutrients [35, 36]. EPTB is also associated with multiple behavioural (e.g. smoking and substance abuse) and clinical (such as diabetes and previous history of TB) risk factors which can affect nutritional status [37, 38], although there is a possibility that pre-existing malnutrition itself may lead to EPTB due to immune deficiency [39].

Although our study attempted to provide an insight into a possible persistence of poor nutritional status from the intensive-phase of treatment, which often occurs due to active TB, a clear differentiation of whether the under-nutrition is persisted or newly occurred needs further investigation. As nutritional status of TB patients could be affected by an array of factors, there is a possibility that circumstances which are not included in our analysis could have played a role in the occurrence of under-nutrition. Our study encompassed a representative sample of all public health care facilities in the study area and individuals who were in the continuous-phase of treatment could readily be reached there. However, the findings cannot directly be extrapolated to people who were receiving TB treatment from health care facilities outside the sampling frame or out of the study setting. As the study relied on participant self-report for most of the explanatory variables, the effect of social desirability and recall biases could not be ruled out.

Conclusions

Our study identified a higher prevalence of under-nutrition than expected in the continuous-phase of TB treatment according to the targets of clinical guidelines. This may suggest potential persistence of poor nutritional status (or a lack of weight gain) from the earlier period of treatment. Socioeconomic and clinical factors contributed to the occurrence of under-nutrition after

completion of intensive-phase treatment in the study population. Potentially, lower awareness of the nutritional impact of TB in association with a lack of formal education, and a limited adequate diet in association with a larger family size constituted the socioeconomic determinants. On the other hand, clinical conditions such as being in the earlier period of continuous-phase treatment and having EPTB increased the likelihood of under-nutrition. Continuous monitoring and support is suggested throughout the treatment course with a particular focus on individuals with a lower socioeconomic background and EPTB.

Abbreviations

AIDS	Acquired immunodeficiency syndrome
AO	Adjusted odds ratio
BMI	Body mass index
CI	Confidence interval
CO	Crude odds ratio
EPTB	Extra pulmonary tuberculosis
HIV	Human immunodeficiency virus
SPSS	Statistical package for social sciences
TB	Tuberculosis

Supplementary Information

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Supplementary Material 1.

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Authors' contributions

RAD conceived the research idea; analysed and interpreted data; drafted the manuscript. ERM, TGF and AG participated in the subsequent revisions of the manuscript. All authors read and approved the final manuscript.

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Data availability

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

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Ethics Review Committee of School of Public Health, Wachemo University. Formal permission was obtained from the authorities of all participating health care facilities. Informed written-consent was sought from all participants after the purpose, risk and benefits of the study was explained to their satisfaction.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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