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Comprehensive assessment of nutrition status, services, dietary intake, and education impact on tuberculosis outpatients in selected hospitals in Dar es Salaam

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Abstract

In sub-Saharan African nations, extreme hunger and poverty pose formidable barriers to maintaining a healthy life and contribute significantly to the tuberculosis (TB) burden. This study aimed to assess the impact of nutrition education and counseling on the nutritional status, dietary intake, and overall health of tuberculosis (TB) outpatients in Dar es Salaam, Tanzania, between September 2023 and January 2024. A total of 156 adult TB patients from Mwananyamala, Buguruni, and Mbagala Rangitatu hospitals participated in face-to-face interviews and underwent nutrition status assessments. These assessments measured Body Mass Index (BMI), albumin, and hemoglobin levels at both baseline and three months post-intervention. Participants received nutrition education focused on the importance of consuming a balanced diet using locally available foods. Undernutrition was defined as a BMI below 18.5 kg/m². Pre-intervention, 29.5% of participants were underweight, and 15.4% had mild anemia, indicative of the malnutrition often seen in TB patients due to the disease's impact on metabolism and nutrient absorption. However, the post-intervention improvements with underweight rates dropping to 9.6% and non-anemic participants rising from 81.4% to 92.3% underscore the impact of nutrition counseling. Results from this study revealed significant changes in Body Mass Index (BMI) categories from pre- to post-intervention among tuberculosis outpatients. In the pre-intervention phase, 32.6% of participants were underweight, and this decreased to 15 individuals' post-intervention. Most participants (58.7%) transitioned to a normal weight category after the intervention. The McNemar test was used to identify significant changes in nutritional status. These provide effectiveness of nutrition education and counseling in improving the nutritional status of TB patients, suggesting its potential as a complementary intervention to standard TB treatment for enhancing recovery outcomes.

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Introduction

Tuberculosis (TB) remains a significant global public health challenge, especially in regions with limited healthcare access (Kilale *et al.*, 2022; Téllez-Navarrete *et al.*, 2021). In Dar es Salaam, Tanzania, TB continues to be a critical concern, with a prevalence rate of 295 cases per 100,000 populations, as reported by the World Health Organization (WHO). As TB management entails a multifaceted approach, increasing attention has been directed towards the nutritional status of TB patients, recognizing its pivotal role in treatment outcomes. Nutrition education and counseling have emerged as promising strategies to combat malnutrition, enhance treatment effectiveness, and mitigate morbidity and mortality rates among TB patients. Thus, this study seeks to evaluate the impact of nutrition education and counseling among TB patients receiving treatment at Mwananyamala Regional referral Hospital, Mbagala Rangi Tatu hospital and Buguruni Health Centre in Dar es Salaam. Tuberculosis (TB) represents more than a lung ailment; it embodies a complex interplay between microbial invasion and the body's response, significantly influenced by an individual's nutritional status (Nguyen *et al.,* 2024). Notably, studies by (Wessel *et al.,* 2021); (Maro *et al.,* 2011) have highlighted the intimate connection between TB and nutrition, corroborated by the World Health Organization's (WHO) emphasis on the substantial impact of undernutrition on TB progression (WHO, 2013). Particularly, primary undernutrition stands out as a critical factor in the shift from latent to active TB infection.

TB is more than a lung disease; it involves a complex interplay between microbial invasion and the body's response, significantly influenced by an individual's nutritional status. Studies by Wessel *et al.* (2021) and Maro *et al.* (2011) have highlighted the strong connection between TB and nutrition, a link underscored by the WHO's emphasis on the impact of undernutrition on TB progression (WHO, 2013). Primary undernutrition is a critical factor in the transition from latent to active TB infection. Undernutrition compromises the immune system, making it less capable of defending against Mycobacterium tuberculosis, which increases susceptibility to TB and the risk of developing active disease.

The burden of TB is significantly exacerbated by undernutrition, with a population-attributable fraction (PAF) estimated at 15% (Carwile *et al.*, 2022). This places undernutrition ahead of other risk factors like HIV and diabetes in terms of TB susceptibility. Addressing nutritional deficiencies is crucial in TB management strategies, as undernutrition not only increases TB susceptibility but also worsens disease severity, complicating treatment and leading to prolonged illness and higher morbidity and mortality rates. Effective interventions should integrate medical treatment with nutritional support and education to provide comprehensive care for TB patients.

By understanding the intricate link between nutrition and TB, public health initiatives can adopt holistic approaches that address both the infectious and nutritional aspects of the disease, ultimately improving outcomes for individuals and communities.

The burden of undernutrition and challenges associated with nutrition management of TB patient is highly recognized in our country. To enhance nutrition management among these patients, Tanzania under the Ministry of Health prepared Nutrition Implementation Guideline for MDR-TB Patients in Tanzania (URT, 2016). This guideline and other national and international documents for the treatment of infectious illnesses will thus be used during provision of nutrition education and counseling. Intervention will be accomplished by nutrition assessment and diagnosis, nutrition education, dietary counseling, continuous follow-up, and lastly, evaluation of intervention's outcomes. The purpose of this study is to analyze effectiveness of the intervention which aimed to improve nutritional status of TB patients.

Materials and methods

Description of study area

This study was conducted at three hospitals from three districts in Dar es Salaam Mwananyamala (Mwananyamala regional referal Hospital), Amana (Buguruni Hospital) and Temeke (Mbagala Rangi Tatu Hospital). According to National TB and Leprosy Program (2021), Dar es Salaam region is the leading with highest prevalence (17%) of notified TB cases throughout the country (NTLP, 2021). These three hospitals were selected basing on the large number of TB patients in Dar es Salaam region.

The study was conducted from September 2023 to January 2024 at three selected hospitals in Dar es Salaam, Tanzania, namely, Mwananyamala regional referral hospital, Buguruni health centre and Mbagala Rangi Tatu Hospital. These hospitals receive a large number of TB patients in Dar es Salaam. According to the National TB and Leprosy Program (2021), Dar es Salaam region has the highest prevalence of notified TB cases in Tanzania, accounting for 17% global fund. Based on registration books available on each hospital, number of recruited patients is ranging as follows Mwananyamala, Mbagala Rangi Tatu and Buguruni can recruit 200-400 quarterly, 400-600 quarterly and 120-200 quarterly consecutively. This justifies why investigator has chosen these hospitals.

Inclusion and exclusion criteria

Inclusion criteria

The study included adults with Tuberculosis aged above 18 years and above attending outpatient clinics at selected hospitals. Eligible patients who were either moderately undernourished or had normal nutritional status were included. Since TB increases the chances of becoming undernourished, patients with normal nutritional status were included to prevent them from developing undernutrition during TB treatment as reported on the study conducted at Kibong'oto Hospital (Nyaki *et al.,* 2016).

Exclusion criteria

The study excluded TB patients who were seriously ill, severely malnourished with medical complications, had a previous history of TB, were diabetic, HIV infected, had multi-drug-resistant TB, had a medical history of cancer or other end-stage diseases, had mental disabilities, were pregnant or lactating mothers, and those who did not sign the consent form.

Study design

A before-after quasi-experimental study design was employed on the intervention study on the same group before intervention and after intervention (Harris *et al.,* 2014). This design is commonly used for nutrition education interventions and allows for immediate assessment of an intervention's effectiveness (Amoore *et al.,* 2023, Sunuwar *et al.,* 2019, Stratton *et al.,* 2019). Also, it is used to evaluate the benefit of a specific intervention (Harris *et al.,* 2014). A similar study by Rachmah analyzed the effectiveness of nutrition education intervention on complementary feeding (Rachmah *et al.,* 2023).

Sampling technique

A purposive selection method was employed to choose these three hospitals to ensure a sufficient number of TB patients for the study and to facilitate timely data collection. This approach allowed for the inclusion of hospitals that had a high volume of TB patients, thereby providing a robust sample size for analysis and ensuring that data could be gathered efficiently within the study timeframe and to allow the adequate time for intervention and capture a representative and comprehensive picture of undernutrition among TB patients. As explained in description of the study area there were adequate number of patients which enabled me to obtain sample size which meets inclusion criteria within one month. Total number of patients who were willing and meet criteria was 79, 86 and 55 for Mwananyamala, Mbagala Rangi Tatu and Buguruni consecutively.

A systematic random sampling procedure was then used to choose eligible patients from the hospital's record book, based on their willingness to participate in the study.

Sample size calculation

The sample size calculation was performed using the formula for a paired t-test in R (software).

Using the power function "pwr.t.test" from the power package (Tan, 2022), the targeted sample was calculated to have 90% power to detect a 40% change in results between before and after the intervention at a 95% confidence interval. The following inputs were used: a significance level (sig.level) of 0.05, a confidence interval of 95% (0.05), and a power of 90% (0.9), with the effect size (d) set to 40% (0.4). The estimated sample size from the formula was 132 participants. Adding 20% for non-respondents, the final sample size was 156 respondents. Formula for Calculation (Power Function): Input: power.t.test (power= 0.90, d= 0.4, sig. level = 0.05, alternative = "two. Sided") Output: Two-sample t-test power calculation n = 132.3106 ≈ 132 (sample size) deltas = 0.4 SD = 1 sig. level = 0.05 power = 0.9 alternative = two. Sided. Note: The sample size (n) is the number in each group. In this study, the groups referred to the same population at different times, specifically at baseline and after twelve weeks. McNemar was used to determine whether the mean change for these pairs was significantly different from zero.

Data collection

Assessment of nutrition status of TB patients at selected hospitals

During the assessment of the nutrition status of the TB outpatients in selected hospital, it was achieved by evaluating the clinical assessment for screening of participants required in the study, anthropometric measurements and conducting biochemical assessments. Baseline Body Mass Index (BMI) was calculated from weight in kg divided by height in m², with weight and height measured using a ShorrBoard© and weight using an ADE M321600 Electronic Floor Scale. Biochemical assessments involved checking serum hemoglobin and albumin levels before providing nutrition education and counseling.

Anthropometric measurements

Anthropometric measurements, included body weight and height, for calculation of Body mass Index (BMI). Baseline BMI, calculated from weight in kg divided by height in m² was used to categorize patients based on their nutritional status. Weight (kg) was measured repeatedly and recorded over three consecutive months to monitor changes, allowing for correction in case of negative progression. Biochemical assessments were conducted twice, at baseline and after twelve weeks. All samples were collected using identification codes and analyzed at the selected hospitals Laboratories.

Biochemical determination

Blood samples 2mL were drawn aseptically from the cubital vein by a hospital registered nurse using the standard operating procedures of Ministry of Health, Tanzania (National Medical Laboratory Standard Operating Procedures for Dispensaries, Version1:2024). The collected samples were used to analyze both albumin and hemoglobin levels.

The blood samples were centrifuged at a low speed (around 3,000-5,000 rpm) for 10-15 minutes to separate the serum from the cellular components. Carefully a clear serum transferred to a clean, sterile tube and stored at -20°C. Before analysis, gently the serum was thawed at room temperature, and mixed thoroughly. Then, the serum albumin assay was done by using Higher Performance Liquid Chromatography (HPLC-Architect plus Ci4100) to determine the level of serum albumin, standard or references used was Multiconstituent control (MCC) for serum albumin to validate the accuracy and reliability results. The Hemoglobin levels were determined using a portable instrument, the Haemoglobinometer (HemoCue; Angelholm, Sweden). According to WHO definitions, anemia for non-pregnant women is defined as hemoglobin levels <12 g/dL, for men <14 g/dL, and severe anemia for both sexes as <7 g/dL. Post-intervention, the expected outcomes for hemoglobin levels were >12 g/dL for females and >14 g/dL for males.

Patients were considered hypoproteinemia when albumin levels were <35 g/L, with the expectation that levels would exceed 35 g/L after the intervention.

After Laboratory analysis the results were recorded and analyzed statistically for intervention comparisons.

Assessment of nutrition services offered by each hospital

This goal was accomplished through an interviewer-administered questionnaire. The questionnaire included questions about the availability of nutrition clinic services, the mode of delivery for nutrition education and counseling, activities involved in nutrition assessment during clinic visits. Outpatients attending the clinic for TB treatment were not beneficiaries of nutrition services; they only received TB medication. This lack of nutritional services support for outpatient TB is concerning, as proper nutrition is vital for the effective management and recovery from TB Questionnaires were pre-tested on patients at hospitals treating TB that were not part of the study.

Determination of the dietary intake of TB outpatients at selected hospitals

This objective was achieved by assessing patients' dietary intake over the previous day's using a food frequency questionnaire (FFQ), developed based on recommendations from FAO and FHI 360 (2016). The questionnaire also gathered information about previous dietary habits, appetite, eating problems or disorders, and food practice behaviors.

The food frequency questionnaire was used for the dietary assessment. The food that was commonly consumed was then decided to represent the findings of the assessment of nutrition status. The results were then assessed using dietary diversity score methodologies. Food groups that were specifically targeted were starchy staples, nuts, and seeds; these food groups were correlated with the patients' body mass index. Second, foods such as dark green leafy vegetables, various fruits and vegetables high in vitamin A, organ meat, meat and fish, eggs, milk, and dairy products were included to demonstrate that an individual has enough nutrients for healthy immune system operation. In addition, an individual's blood albumin level was determined by their consumption of organ meat, fish, eggs, milk, and milk products.

Evaluation of the impacts of nutrition interventions among TB outpatients on at selected hospitals in Dar es Salaam

This objective was conducted into three major phases. The first phase, from September to October, focused on recruitment and the implementation of nutrition education and counseling activities. During this period, participants were enrolled in the study and received targeted nutritional guidance to support their TB treatment. The second phase, spanning from November to December, involved follow-up activities. During this time, regular check-ins (face to face) was conducted to assess the participants' progress and adherence to the nutritional recommendations.

The final phase, in January, was dedicated to monitoring and evaluation. This phase involved a comprehensive assessment of the outcomes, including measuring improvements in nutritional status and overall health, to evaluate the effectiveness of the intervention. Literature indicated that, the outcomes of nutrition education and counseling interventions typically become apparent from the 8th week onwards (Aslam *et al.,* 2021).

Data management, data quality control, and statistical analysis

Data management

Information collected from the questionnaire included both names phone numbers and code numbers. Names and phone numbers were used for communication purposes during the provision of nutrition education, counseling and follow-up. Anonymity and confidentiality were guaranteed by using only identification code numbers during the collection of blood samples and data processing.

Data quality control

To ensure data quality control, questionnaires were prepared in English and later translated into Swahili. Registered nurses were trained and used

to collect blood samples from the patients and measure hemoglobin level using the portable machine as they were instructed under supervision of principal investigator. The albumin content of the blood samples was at Mwananyamala Hospital. Patients were questioned further during counseling sessions and interviews to get further information on any topics that weren't clear (Degefa *et al.,* 2021). Questionnaires were pre-tested at Amana hospital on 5% of the calculated sample size (Tadesse *et al.,* 2023; Diddana *et al.,* 2019). Collected questionnaires were closely monitored and reviewed daily for completeness, correctness and consistency. Collected data were saved to computer device and kept confidential and only patient code numbers appeared in the database during data analysis (Degefa *et al.,* 2021).

Data analysis

Data collected were analyzed using IBM, SPSS (Statistical Package for the Social Sciences) Statistics version 20.0. Descriptive statistics for each variable, such as mean, frequencies and percentages, were presented in tables and charts. Regression analyses were used to compare weight gain changes over three months. McNemar test was used to determine changes in Body Mass Index (BMI) categories from pre- to post-intervention among tuberculosis outpatients.

Study protocol and ethical clearance

Ethical clearance was obtained from the Kibong'oto Infectious Diseases Hospital (KIDH), The Nelson Mandela African Institution of Science and Technology (NM-AIST), the Centre for Educational Development in Health Arusha (CEDHA) and Health Research Committee (KNCHREC). Formal permission was secured from each hospital's management. Written informed consent forms (see appendix) were obtained from each study participant before any procedures were conducted. Confidentiality of all collected information was maintained throughout the study. All participants had the right to withdraw from the study at any point without any repercussions.

Results and discussion

Sociodemographic characteristics of patients TB patients in selected hospital, in Dar es Salaam

The study assessed the sociodemographic characteristics of 156 tuberculosis outpatients in selected hospitals in Dar es Salaam. The mean age of participants was 36.87 years (SD ± 12.1).

Table 1. Sociodemographic characteristics (N=156)

Variables	Frequency (N)	Percent (%)
Age (years)	Mean ± SD (36.87 ± 12.1)	
<25	27	17.3
25-49	103	66.0
≥50	26	16.7
Sex		
Female	36	23.1
Male	120	76.9
Marital status		
Single	75	48.1
Married	71	45.5
Divorced or separated	6	3.8
Widow	4	2.6
Education level		
No formal education	11	7.1
Primary education	100	64.1
Secondary education	36	23.1
College or University	9	5.8
Employment status		
Employed	31	19.9
Self-employed	81	51.9
Unemployed	44	28.2
Income level (TZS)		
No income	42	26.9
<100,000	22	14.1
100,000-500,000	86	55.1
600,000-1000,000	6	3.8

Approximately two-thirds of the participants 103 (66%) were aged between 25 and 49 years, while 27(17.3%) were under 25 years, and a few participants 26 (16.7%) were 50 years or older.

The majority of participants 120 (76.9%) were male, while 36 (23.1%) were female. Almost half of the participants 75 (48.1%) were single, with 71 (45.5%) married, and a few participants were either divorced or separated 6 (3.8%) or widowed (2.6%). Most participants 100 (64.1%) had completed primary education; while a smaller proportion 36 (23.1%) had secondary education, 9 (5.8%) had college or university qualifications, and a few participants (7.1%) had no formal education.

Regarding employment, more than half of the participants 81 (51.9%) were self-employed, 44 (28.2%) were unemployed, and a minority 32 (19.9%) were employed. In terms of income, over half of the participants 86 (55.1%) earned between 100,000 and 500,000 Tanzanian shillings, 42 (26.9%) had no income, and only a few 6 (3.8%) had incomes between 600,000 and 1,000,000 shillings as shown Table 1. The sociodemographic data highlight several influential factors in the nutritional health of TB patients. The majority of participants were female, aged between 25 and 49, with limited formal education and low income of 100,000-500,000.

Socioeconomic constraints, such as low income and limited education, are known to affect access to quality food and healthcare, as noted in several other studies (Aslam *et al.,* 2021, Nidoi *et al.,* 2021), who found similar patterns among TB patients. This demographic profile suggests that TB patients may require additional financial and educational support to meet their nutritional needs effectively. Socioeconomic status of patients is viewed as major patient factor which act as a barrier to nutrition assessment, counselling, and support to TB patients (21). Therefore, being poor low level of education is associated being malnourished which has been demonstrated in this study as well as study from India (Sinha *et al.,* 2022).

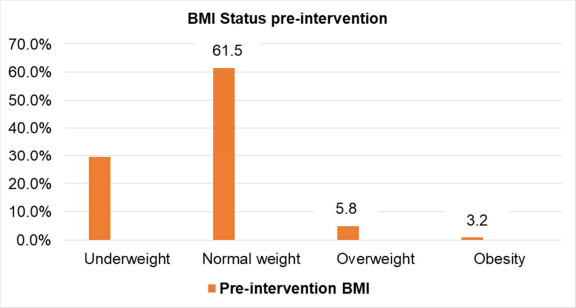

Fig. 1. Pre-intervention nutrition status of tuberculosis outpatients using body mass index (BMI) categories

Nutrition status of TB outpatients at selected hospital in Dar es Salaam

Pre-intervention body mass index

The study assessed the pre-intervention nutritional status of tuberculosis outpatients using Body Mass Index (BMI) categories. Most participants (61.5%) had a normal weight, while nearly one-third (29.5%) were underweight. A few participants (5.8%) were classified, as overweight, and only a small percentage (3.2%) were obese as shown in Fig. 1. The pre-intervention assessment of tuberculosis outpatients' nutritional status using Body Mass Index (BMI) categories revealed that a majority (61.5%) of participants had a normal weight. However, a significant proportion (29.5%) was underweight, which is a concern, as undernutrition is a well-documented risk factor for poor TB treatment outcomes. Malnutrition weakens the immune system, making it difficult for the body to fight infections, and can prolong recovery time (Tadesse *et al.,* 2023). A small percentage (5.8%) of the participants were overweight, and only 3.2% were classified as obese. These findings highlight the nutritional challenges among TB patients, particularly the high prevalence of underweight individuals, which aligns with previous research indicating that TB and malnutrition often coexist.

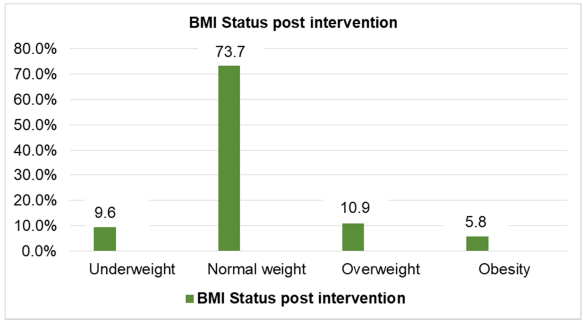

Fig. 2. Post-intervention nutrition status of tuberculosis outpatients using body mass index (BMI) categories

Post intervention body mass index

The post-intervention assessment of nutritional status using Body Mass Index (BMI) categories showed that most participants (73.7%) had a normal weight. A few participants n (9.6%) remained underweight, while (10.9%) were classified as overweight, and 5.8% were obese as shown in (Fig. 2). Following the nutritional intervention, the post-intervention BMI assessment showed a significant improvement in the nutritional status of participants.

The proportion of individuals with normal weight increased from 61.5% to 73.7%, indicating that dietary interventions contributed positively to the patients' recovery. The percentage of underweight individuals dropped from 29.5% to 9.6%, suggesting that nutrition education and counseling played a crucial role in improving dietary intake and overall nutritional well-being. Moreover, the number of overweight participants increased slightly to 10.9%, and obesity cases also rose to 5.8% The large differences are contributed by comorbid infection of HIV to the study population in the study compared to this one (Bakari *et al.,* 2013) and similarly to another study from Iraq (Aslam *et al.,* 2021). This increase in overweight and obese individuals might indicate that some participants gained weight beyond the normal range due to improved dietary intake or reduced disease severity. These results reinforce the importance of targeted nutritional support in managing TB patients to optimize treatment outcomes.

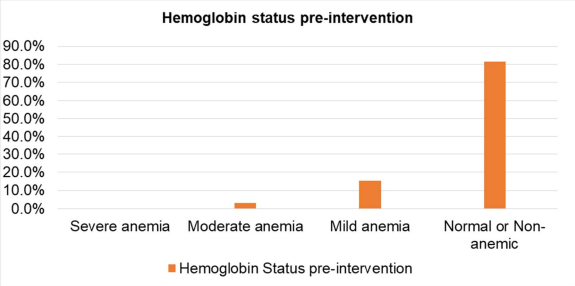

Fig. 3. Pre-intervention nutrition status of tuberculosis outpatients using hemoglobin (HB) level

Pre- intervention HB

The hemoglobin (HB) levels before the intervention demonstrated that most participants (81.4%) had normal or non-anemic levels. However, 15.4% had mild anemia, and 3.2% had moderate anemia. Anemia is often associated with TB due to chronic inflammation, malabsorption of essential nutrients, and poor dietary intake. The presence of anemia in some patients could have negatively impacted their overall health and energy levels, further complicating TB treatment. Fortunately, no cases of severe anemia were observed in the study population as shown in Fig. 3.

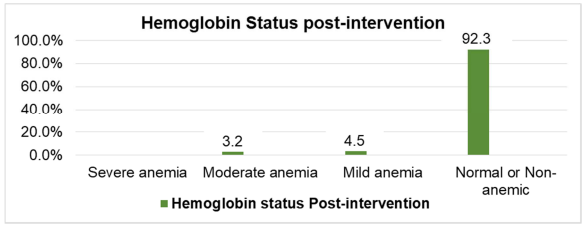

Fig. 4. Post-intervention nutrition status of tuberculosis outpatients using hemoglobin (HB) levels

Post intervention HB

The post-intervention hemoglobin (HB) assessment showed that the vast majority of participants (92.3%) had normal or non-anemic levels, while 4.5% had mild anemia. A few participants (3.2%) still experienced moderate anemia, and there were no cases of severe anemia as shown in Fig. 4. Post-intervention notably shows the improvement in participants' anemia status. The proportion of participants with normal hemoglobin levels increased from 81.4% to 92.3%, while those with mild anemia decreased from 15.4% to 4.5%. The percentage of individuals with moderate anemia remained constant at 3.2%, and there were no cases of severe anemia. This improvement suggests that the intervention, possibly through improved dietary intake and counseling, played a role in enhancing iron status and overall blood health. This finding is crucial because adequate hemoglobin levels contribute to better oxygen transport and overall health, which is particularly important for TB patients, who often experience fatigue and weakness.

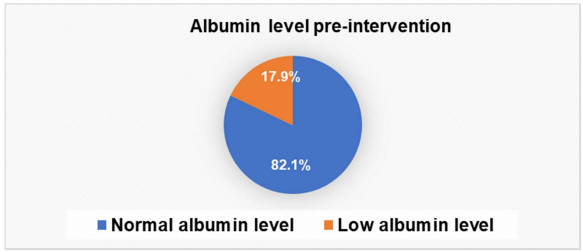

Fig. 5. Pre-intervention nutrition status of tuberculosis outpatients using albumin level

Pre-intervention on albumin levels

The pre-intervention assessment of albumin levels indicated that the majority of participants (82.1%) had albumin levels of 35 g/dL or higher, while 17.9%

had albumin levels below 35 g/dL as shown on Fig. 5. Albumin is a key marker of nutritional status, and low albumin levels are often associated with poor health outcomes, inflammation, and chronic infections such as TB. The presence of a considerable percentage of individuals with low albumin levels suggests that some TB patients were experiencing malnutrition and systemic inflammation before the intervention.

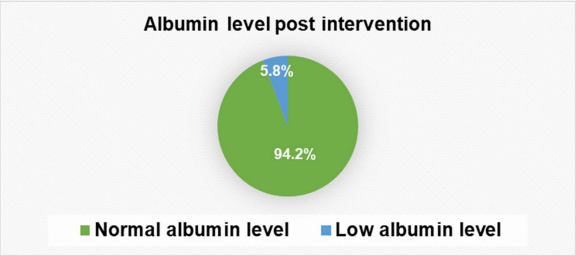

Fig. 6. Post-intervention nutrition status of tuberculosis outpatients using albumin level

Post intervention on albumin levels

Post-intervention albumin levels demonstrated significant improvement, with 94.2% of participants having albumin levels of 35 g/dL or higher, while only 5.8% remained below this level as shown in Fig. 6. This positive change indicates that the nutritional intervention helped improve protein intake, leading to better nutritional and overall health status. Given that albumin plays a crucial role in maintaining fluid balance and transporting essential nutrients, an increase in its levels suggests improved overall health and a reduced risk of complications in TB patients (Bakari *et al.,* 2013, Bhargava*et al.,* 2013).

Nutrition service offered by hospital to outpatients with TB in selected hospitals

Compared to the general population, TB patients in this study demonstrated significantly higher levels of malnutrition and nutritional deficiencies, which is consistent with existing literature (Fig. 7). Studies (Bhargava *et al.,* 2013, Gupta *et al.,* 2009) highlight that TB patients generally exhibit poorer nutritional profiles than the general population, primarily due to the disease's impact on nutrient absorption and increased metabolic demands. In this study, the higher prevalence of underweight individuals and mild anemia in the TB outpatient population further emphasizes the unique nutritional needs of TB patients, who may require greater caloric and protein intake than typical populations at our setting.

Fig. 7. Nutrition services offered by hospital to tuberculosis outpatients at selected hospitals

Dietary intake

The assessment of dietary diversity among tuberculosis outpatients indicated that a significant majority of participants (84.6%) had adequate dietary intake, defined as consuming five or more food groups, while a smaller proportion (15.4%) had inadequate dietary intake, indicating consumption of fewer than five food groups as shown in Fig. 8.

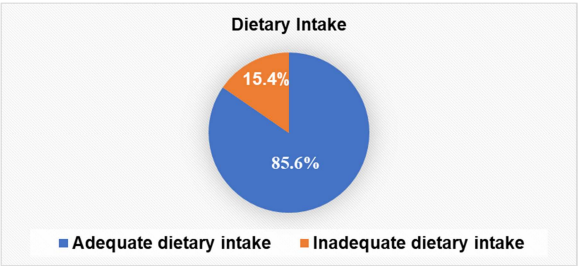

Fig. 8. Dietary intake adequacy of tuberculosis outpatients in selected hospitals

Dietary intake consumed and food practice behaviour of the TB outpatients

The assessment of dietary intake and food practice behavior among tuberculosis outpatients revealed that all participants (100.0%) consumed carbohydrates. A significant majority (76.9%) reported consuming pulses, while 23.1% did not. Only a small percentage (28.8%) included legumes in their diet, with most participants (71.2%) not consuming them. The intake of dark green vegetables was high, with 92.3% of participants including them in their diet, while 7.7% did not. Regarding vitamin A-rich

foods, 71.2% of participants consumed them, whereas 28.8% did not. Additionally, 66.7% reported consuming other vegetables and fruits, while 33.3% did not. The consumption of offal was low, with only 14.7% of participants including it in their diet, and a large majority (85.3%) did not. In terms of meat or fish, 84.0% reported consuming these foods, while 16.0% did not. The intake of eggs was low, with only 24.4% of participants consuming them, and 75.6% did not. Lastly, 35.3% of participants included milk in their diet, while 64.7% did not as shown in Fig. 9.

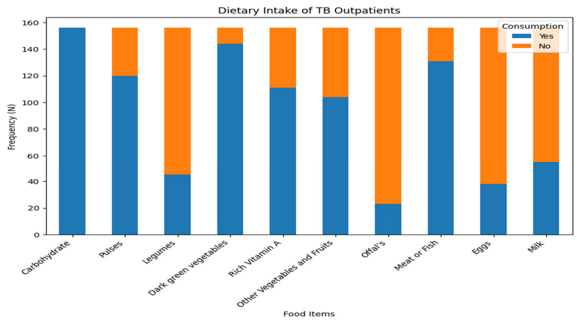

Fig. 9. Dietary intake frequencies of tuberculosis outpatients in selected hospitals

Effect of nutrition education and counselling given to TB patients on treatment at selected hospitals

The analysis of dietary patterns found food consumption trends and gaps in dietary diversity among TB outpatients. In this study heavily relied on carbohydrates, with 100% of participants reporting daily carbohydrate intake. However, protein sources such as eggs (24.4%), milk (35.3%), and offal (14.7%) were under-consumed, which is concerning given the critical role of protein in immune function and recovery for TB patients. This mirrors findings from a similar study (Ren *et al.,* 2019), which found similar dietary imbalances in Tanzanian TB patients.

Similar pattern was noted in India where is energy and protein intake of patients with TB is below the recommended daily intake (Wessel *et al.,* 2021). However, what is good for tuberculosis patients is low carbohydrate and high protein (Baceloet *al.,* 2017). Thus, this study's findings point out the need for dietary intervention even more to TB patient to ensure continuum of care to these patients and ensure good quality of life as nutritional supplementation may represent a novel approach for fast recovery in TB patients and raising nutritional status of population may prove to be an effective measure to control tuberculosis in underdeveloped areas of world (Gupta *et al.,* 2009; Bhargava *et al.,* 2013; Franke *et al.,* 2024).

The study also revealed the absence of formal nutritional services for TB patients in the selected hospitals, as it was completely absent in contrasting with broader healthcare services available to the general population. This finding is similar to observations seen in Malawi, noted that healthcare systems in resource-limited settings often lack structured nutritional support for TB patients (Franke *et al.,* 2024). Therefore, whatever the outcome of this debate, providing good nutrition to TB patients is an essential step to reduce the high mortality associated with TB infection in sub-Saharan Africa. Our findings have important public health implications for TB control in our setting and in other high HIV-TB burden countries of sub-Saharan Africa.

Conclusion

Overall, the findings indicate that the nutritional intervention had a positive impact on TB outpatients' nutritional status, as evidenced by improved BMI, hemoglobin levels, and albumin levels. The reduction in underweight prevalence, improvement in anemia status, and increase in normal albumin levels highlight the effectiveness of nutrition education and counseling in supporting TB treatment. These results underscore the need for integrating nutritional support into TB management programs to enhance patient recovery and treatment outcomes. Future research should explore the long-term impact of such interventions and assess additional biomarkers to provide a more comprehensive understanding of the relationship between nutrition and TB outcomes.

Recommendations

Findings from this study have shown the impact of nutrition education and counseling on improvement of TB patient's nutrition status as evidenced by

improvement in BMI, Hemoglobin level and albumin level. Therefore, this study suggests that,

Nutrition education and counseling can be an important service to be given to TB patients to improve their nutrition status as it has been done to HIV clinics. Also, this study recommends for routine regular follow-up and assessment of patient's nutrition status during clinics (re-filling of medication) to enhance healthy eating behavior, which will also minimize the risks of TB relapse by strengthening patient's immune system.

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