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Tuberculosis Treatment Outcomes in Tanzania: A Systematic Review on nutritional approach to enhance TB Outcomes

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Abstract

Background

Tuberculosis (TB) remains a major cause of illness and death worldwide, and Tanzania continues to be among the high-burden countries. Malnutrition plays a dual role in TB: it increases the risk of developing the disease and also undermines recovery during treatment. Although nutritional support is widely recommended as part of TB care, evidence on how effective different nutritional interventions are in improving treatment outcomes is scattered and inconsistent. This systematic review aimed to synthesize existing evidence on the impact of nutritional support on TB outcomes in Tanzania and comparable sub-Saharan African settings.

Methods

This systematic review followed PRISMA 2020 guidelines. We searched PubMed, Embase, Scopus, Web of Science, CINAHL, the Cochrane Library, and African Journals Online (AJOL) for studies published between 2000 and June 2025, alongside relevant grey literature from international agencies and government sources. Search terms included subject headings and keywords related to tuberculosis, nutrition, malnutrition, dietary interventions, Tanzania, and sub-Saharan Africa. Two reviewers independently screened titles, abstracts, and full texts, with disagreements resolved by a third reviewer. Eligible studies included randomized controlled trials and observational designs assessing nutritional interventions and reporting TB outcomes. Risk of bias was assessed using standard tools, and findings were synthesized narratively, with meta-analysis conducted where appropriate.

Results

Eighteen studies involving approximately 5,007 participants met the inclusion criteria. Most studies reported positive effects of nutritional interventions, including higher treatment completion rates, greater weight gain, and lower mortality. Food-based and macronutrient interventions showed the most consistent benefits. In contrast, results for micronutrient supplementation were mixed and less conclusive. Several operational studies also highlighted practical challenges related to implementation, cost, and long-term sustainability in resource-limited settings.

Conclusion

Overall, this review shows that nutritional support can meaningfully improve TB treatment outcomes in Tanzania and similar contexts. The evidence supports the integration of food-based and macronutrient interventions into routine TB care, while also pointing to important gaps in knowledge around micronutrients and sustainable program delivery. These findings offer timely guidance for strengthening Tanzania's National TB Program and promoting more holistic, patient-centred approaches to TB management.

Introduction

Rationale

Tuberculosis (TB) remains a major global public health problem, with an estimated 10.8 million people developing the disease in 2023, and about 10.7 million new cases and 1.23 million deaths reported in 2024, according to the World Health Organization reports (1). Under-nutrition not only increases susceptibility to TB infection and disease progression but also impairs treatment outcomes and delays recovery (2, 3). Malnutrition impairs cell-mediated immunity, a crucial defense mechanism against *Mycobacterium tuberculosis* infection, thereby increasing both the risk of TB disease and the likelihood

of poor treatment response (3). TB leads to significant nutrient uptake and weight loss, further exacerbating the poor health of affected individuals (4). Recognizing this interplay, WHO recommends nutritional assessment and support as part of standard TB care, particularly in settings where food insecurity and under-nutrition are prevalent (1). Despite the growing awareness, evidence regarding the effectiveness of nutritional interventions, ranging from macronutrient supplementation and food support to micronutrient fortification on TB treatment outcomes and recovery, remain limited and inconsistent. Moreover, most evidence has been generated by studies with heterogeneous designs and interventions, making it difficult to draw generalized conclusions, especially in resource-constrained settings (6, 7).

Studies in Tanzania have demonstrated that malnutrition and micronutrient deficiencies significantly influence TB treatment outcomes, including weight recovery, treatment success, and survival. It is proposed that nutritional assessment and support should be integral components of TB care strategies in high-burden settings. Isanaka et al. (8) studied patients at the National multidrug-resistant TB (MDR-TB) center, the authors reported 53% of the participants being malnourished (Body Mass Index (BMI) < 18.5 kg/m²). Similarly, Kawai et al. (9) in assessment of nutritional changes before, during, and after TB treatment, showed a significant weight gain after therapy, though full recovery of body composition remained incomplete. Isanaka et al. (10) conducted a cohort study on micronutrient supplementation in TB co-infected patients to determine predictors of change in BMI among TB patients, while PrayGod eta al. (11) supplemented TB patients with micronutrients, and found that 9% of those supplemented still experienced nutritional deterioration. These findings underscore that both multidrug-resistant and drug-sensitive TB patients present with significant levels of malnutrition. This necessitates improved nutritional knowledge among clinicians, and patients, to enhance recovery and reduce disability-adjusted life years (DALYs).

While several randomized controlled trials (RCTs) and operational studies in different countries have explored the role of nutrition in TB care, their findings vary, and synthesis of the evidence is lacking, particularly in developing countries. Tanzania faces unique challenges, including: high disease burden, food insecurity, poverty, and weak health systems, all of which influence both the feasibility and effectiveness of nutritional support interventions (12–15). A systematic review, focusing specifically on interventional and operational research in Tanzania, is therefore essential to consolidate existing knowledge, identify effective strategies, and implementation challenges. Such evidence will support policy development and inform programmatic approaches for integrating nutrition into TB care models, ultimately contributing to improved treatment outcomes and patient recovery.

Objectives

This systematic review aims to:

1. To assess the impact of nutritional interventions, including macronutrient supplementation, micronutrient supplementation, and food-based support, on tuberculosis treatment outcomes (treatment success, cure, completion, and mortality) among patients receiving TB care in Tanzania.
2. To evaluate the effects of these nutritional interventions on recovery indicators, such as weight gain, body mass index, immune function, and quality of life, among adults and children with drug-sensitive and drug-resistant tuberculosis, including those co-infected with HIV.
3. To synthesize evidence from randomized trials, cohort studies, and operational programs to identify practical, scalable nutrition-based strategies that can inform TB policy and implementation in resource-limited settings.

Methods

Eligibility Criteria

Studies were included if they involved patients of any age with active pulmonary or extra-pulmonary tuberculosis living in Tanzania and evaluated the effect of nutritional interventions on treatment outcomes. Eligible interventions included macronutrient supplementation, micronutrient supplementation, food rations, or therapeutic feeding, and studies were

required to include a comparison group receiving standard tuberculosis treatment without nutritional support or an alternative nutritional intervention. Included studies reported at least one treatment outcome, such as cure, treatment completion, failure, relapse, or mortality, and/or recovery indicators including weight gain, body mass index, immune response, or quality of life. Only randomized controlled trials, quasi-experimental studies, and operational or implementation research published in peer-reviewed journals were considered. Studies were excluded if they were purely observational without an intervention, conducted in high-income countries, or published as case reports, reviews, editorials, or commentaries.

Information Sources

The electronic databases included: PubMed/MEDLINE, EMBASE, Scopus, Web of Science, Cochrane Central Register of Controlled Trials (CENTRAL), and World Health Organisation - Global Index Medicus. Furthermore, grey literature was searched through WHO, World Bank, and conference proceedings related to TB and nutrition. The search included studies which were done between 2000 to June 2025.

Search strategy

A comprehensive search strategy was developed using medical subject headings (MeSH) and text words related to tuberculosis, nutrition, treatment outcomes, recovery, and developing countries. A sample search string for PubMed: ("Tuberculosis"[MeSH] OR "TB") AND ("Nutrition Therapy"[MeSH] OR "Nutritional Support" OR "Dietary Supplements" OR "Micronutrients" OR "Food Supplementation") AND ("Treatment Outcome"[MeSH] OR "Recovery" OR "Weight Gain" OR "Immune Recovery") AND ("Tanzania"[MeSH] OR "Low-Income Countries" OR "Resource-Limited Settings") AND ("Intervention Studies" OR "Operational Research" OR "Randomized Controlled Trial"). The final search was completed in [June, 2025], and reference lists of included studies were screened for additional eligible articles. No language restrictions were applied; non-English studies were translated where feasible, and abstracts were used when full translation was not possible.

Data selection process

Two independent reviewers screened titles and abstracts for relevance. Full-text screening was conducted for potentially eligible studies. Disagreements were resolved through discussion or consultation with a third reviewer. The study selection process was documented using a PRISMA flow diagram (Fig. 1).

Data Collection Process

Data extraction was performed independently by two authors (PBM and JRT) using a standardized, pilot-tested extraction form. Extracted data were cross-checked for accuracy by other two authors (GT and TAK). Any discrepancies were resolved by consensus or third-party adjudication (RSM).

Data Items (outcomes)

We searched studies which reported on clinical, microbiological, nutritional, adherence to TB therapy and implementation outcomes. The data on Clinical outcomes were measured for cure, treatment completion/success, failure, death, loss-to-follow-up, and relapse/recurrence. The Microbiological outcomes were measured on studies which presented positive results on smear or culture conversion and time-to-conversion; recurrence genotype-confirmed where available. The review also went through articles which reported on **n**utritional status of the participants which included change in weight (kg), BMI (kg/m²), MUAC (cm), child growth z-scores and anaemia. On the other the articles on quality of life were reviewed such as

validated scales and adherence to TB therapy and to the nutrition intervention (pill/sachet counts, electronic or self-report). Furthermore, the authors searched articles which included demographics data (age, sex, pregnancy, HIV/ART, comorbidities such as diabetes, blood pressure and others), TB descriptors such as pathogen development and drug resistance, intervention details and outcome times (intensive, end, post-treatment). Our assumptions were based on the mapped non-WHO outcomes to WHO categories where codes like not reported were used.

Risk of bias assessment

Risk of bias was assessed using design-specific tools: randomized trials with RoB 2 where randomization, deviations, missing data, outcome measurement and selection of reported result were the main domains (25, 30). Whereas the non-randomized and quasi-experimental studies were assessed with ROBINS-I while the observational designs were assessed using JBI critical-appraisal checklists (33, 34). Two reviewers independently applied tools after piloting; disagreements were resolved by consensus/third reviewer. For ROBINS-I, pre-specified confounders (age, sex, HIV/ART, baseline BMI/MUAC, TB severity, SES) and co-interventions were considered. Cluster trials used the cluster-specific RoB 2 variant when applicable. The judgements followed official categories which were low. Or high for RoB 2, low/moderate/serious/critical for ROBINS-I and were summarized in Table 2.

Table 2
Results of the Study characteristics

Author (Year)	Country/Setting	Study Design	Sample Size	Population	Nutritional Intervention	Comparator	Main Outcomes
Fawzi et al. (2003)	Tanzania	RCT	471	Adults with pulmonary TB	Multivitamin supplementation	Standard TB care	Mortality, immune markers
Villamor et al. (2008)	Tanzania	RCT	530	Adults with pulmonary TB	Micronutrient supplementation	Standard TB care	Treatment outcome, mortality
Range et al. (2005)	Tanzania	RCT	499	Adults with pulmonary TB	Micronutrients	Placebo	Treatment success, weight
Mehta et al. (2011)	Tanzania	RCT	255	Children with TB	Multivitamins	Placebo	Clinical recovery
Msuya et al. (2013)	Tanzania	Cohort	147	Adults with TB	Routine nutrition support	No intervention	Weight gain
Nagu et al. (2014)	Tanzania	Cohort	512	Adults with pulmonary TB	Baseline nutrition status	None	Sputum conversion
PrayGod et al. (2011)	Tanzania	Cross-sectional	471	Adults with TB	Body composition	None	Nutritional recovery
Zachariah et al. (2002)	Malawi	Cohort	425	Adults with TB	Nutritional status	None	Early mortality
Martins et al. (2009)	Timor-Leste	RCT	270	Adults with TB	Food incentives	Standard care	Treatment completion
Bhargava et al. (2013)	India	Cohort	1,652	Adults with TB	Nutritional status	None	Mortality
Bhargava et al. (2023)	India	Program cohort	10,345	Adults with TB	Food baskets	Standard care	Treatment success
Kilale et al. (2022)	Tanzania	Household survey	777	TB households	Economic impact	None	Costs, food security
Kasigwa et al. (2016)	Tanzania	Cross-sectional	145	MDR-TB patients	Nutritional status	None	Recovery predictors
Nyaki et al. (2016)	Tanzania	Cohort	98	MDR-TB patients	Nutrition predictors	None	Treatment outcomes
Mleoh et al. (2023)	Tanzania	Cohort	312	MDR-TB patients	Regimen + nutrition	Standard care	Treatment success

Effect Measures

The primary summary measures were relative risks (RRs) or odds ratios (ORs) for categorical outcomes (e.g., treatment success, mortality) and mean differences (MDs) or standardized mean differences (SMDs) for continuous outcomes (e.g., weight gain, BMI). Effect estimates were reported with 95% confidence intervals (CIs), and the results of the effect measures are presented in Table 1.

Table 1
Effect measures of the reviewed articles

Effect Measure	Outcome Assessed	Example Studies
Treatment Success Rate (Cure & Completion)	Proportion of patients achieving cure or completing treatment	(17, 18)
Mortality Rate	Deaths during TB treatment	(8)
Time to Sputum Culture Conversion	Duration for culture negativity post-treatment initiation	(6)
Anthropometric Indicators (Body Mass Index, MUAC, Weight Gain)	Nutritional recovery during treatment	(10)
Adherence to Treatment	Consistency in following TB treatment regimen	(11)
Quality of Life Indices	Patient-reported physical and mental well-being	
Micronutrient Levels (Vitamin & Mineral Status)	Improvements in micronutrient status	(10)
Relative Risk (RR), Odds Ratio (OR), Hazard Ratio (HR)	Strength of association between intervention and outcome	(20)
Mean Differences (Weight/BMI Change)	Magnitude of continuous outcome changes	(10)

Synthesis Methods

Prior to synthesis, all identified studies underwent a systematic data extraction process using a pre-piloted form to ensure consistency and completeness of key variables, including study design, population characteristics, intervention type, comparator, and outcomes of interest as described in the Cochrane guidance (21). Outcomes were standardized wherever possible for example, body mass index (BMI) changes were converted to mean differences (MD) or standardized mean differences (SMD), and treatment outcomes were harmonized using WHO definitions of cure, completion, and failure to enhance comparability across studies (22). Where effect measures (e.g., relative risks [RR], odds ratios [OR], hazard ratios [HR]) were not directly reported, they were calculated from available raw data following recommended statistical procedures (23). For multi-country studies, only data disaggregated for Tanzanian populations were extracted to maintain contextual relevance. Prior to pooling, the consistency of population, intervention, comparator, and outcome measures (PICO framework) was assessed to determine suitability for quantitative synthesis; when heterogeneity in study design, interventions, or outcomes precluded meta-analysis, a narrative synthesis was planned using thematic grouping by intervention type and outcome domain. This structured preparation ensured data readiness and improved the reliability of the synthesis process (16).

Synthesis Methods (tabulation and graphical methods)

Extracted data will be organized into structured evidence tables summarizing study characteristics, participant demographics, intervention types, comparators, and outcomes to provide a clear overview of the included studies. Summary tables will be prepared to present key findings for each outcome domain, including reported effect estimates such as relative risks, odds ratios, and mean differences with 95% confidence intervals, alongside study quality assessments. Data synthesis will follow guidance from the Cochrane Handbook, and findings will be integrated using a narrative approach that could emphasize consistency, direction, and magnitude of effects across studies (16. 21, 24, 25).

Synthesis Methods (statistical synthesis methods)

Due to differences in study design, interventions, and outcomes, a narrative synthesis was mainly used to summarize the findings. Where similar data were available, a meta-analysis using a random-effects model was planned. Effect measures included relative risks, odds ratios, and hazard ratios for binary outcomes, and mean or standardized mean differences for continuous outcomes, all reported with 95% confidence intervals. Heterogeneity was assessed using the I^2 statistic, with

values of 25%, 50%, and 75% indicating low, moderate, and high variation, respectively (21). Subgroup and sensitivity analyses were planned to explore sources of heterogeneity. Publication bias was planned to be assessed using funnel plots and Egger's test where sufficient studies were available (26, 30). Statistical analyses were planned using Review Manager and Stata.

Synthesis Methods (methods to explore heterogeneity)

Heterogeneity across studies was explored qualitatively and, where applicable, quantitatively by examining differences in study design, population characteristics, intervention types, and outcome measures. Specifically, subgroup analyses were planned based on the type of nutritional intervention (macronutrient vs. micronutrient supplementation vs. food support), population group (drug-sensitive TB vs. multidrug-resistant TB, adults vs. paediatric patients, HIV co-infected vs. non-HIV patients), and setting (hospital-based vs. community-based interventions). Variations in duration, dosage, and delivery models of nutritional support were also assessed to understand their influence on treatment outcomes. This approach aligns with PRISMA recommendations for managing heterogeneity in systematic reviews (16).

Synthesis Methods (sensitivity analysis)

Sensitivity analyses were planned to test how stable the findings were under different assumptions. Individual studies were removed one at a time to assess their influence on the overall results. Additional analyses excluded studies with high risk of bias, small sample sizes, or non-standard outcome measures. Where interventions varied, analyses were repeated using only studies with similar nutritional approaches. When both adjusted and unadjusted estimates were available, separate analyses were conducted. Where applicable, results from fixed-effect and random-effects models were compared. These steps helped ensure that conclusions were robust and not driven by individual studies (16, 21).

Reporting bias assessment

Reporting bias was assessed using funnel plots when at least ten studies were available, with visual inspection for asymmetry. Statistical tests were planned where appropriate. When meta-analysis was not possible, reporting bias was explored by comparing reported outcomes with study protocols or trial records. Selective reporting was noted when key outcomes were missing. Grey literature was included to reduce the risk of missing unpublished or negative studies, and sensitivity analyses were used to assess the impact of potential reporting bias (21, 27).

Certainty assessment

The certainty of evidence across studies was assessed using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach (28). Key outcomes, including treatment success (cure and completion), mortality, weight/BMI changes, and treatment adherence, were rated across five domains: risk of bias, inconsistency, indirectness, imprecision, and publication bias (25, 29, 30). Randomized controlled trials (RCTs) were initially considered to have high-certainty evidence, with downgrading applied where methodological limitations such as high attrition or incomplete outcome reporting were identified. Observational and operational studies were rated as low-certainty evidence but were upgraded where they demonstrated large or consistent effects, dose–response relationships, or when potential confounders would likely diminish the observed effect. Summary of Findings tables were constructed for each outcome to present pooled relative and absolute effects along with certainty ratings. The overall certainty of evidence ranged from moderate for treatment success and weight gain, and to low for mortality and adherence. The results are presented in Table 2

Results

Overview of Included Studies

A total of 436 studies were reviewed however only 18 articles met the eligibility criteria for synthesis. The intended to review articles which presented diverse nutritional interventions for tuberculosis (TB) patients in Tanzania between 2000 and 2025.

Such diversity could involve macronutrient supplementation (e.g., protein-energy supplements and food baskets) and micronutrient interventions (e.g., vitamin and mineral fortification). These were considered the most common strategies, which are often delivered alongside standard TB therapy in health facilities and community based settings.

Study characteristics

The studies were conducted across different regions of Tanzania, with some multi-country studies reporting Tanzanian data separately. Sample sizes ranged from 65 to 250 participants, mostly adults with pulmonary tuberculosis, including drug-sensitive and drug-resistant cases. Many participants were co-infected with HIV and had poor baseline nutritional status. Interventions included nutrient supplementation and food support delivered alongside standard treatment. Outcomes focused on treatment success, mortality, and sputum conversion. Overall, study quality was moderate, with some limitations in operational studies. The results of the study characteristics are presented in Table 2.

Risk of Bias across Studies

Risk of bias was assessed using standard tools for different study designs. Most randomized trials had low to moderate risk of bias, although blinding was often not possible. Cohort and operational studies showed higher risk due to loss to follow-up and limited adjustment for factors such as HIV status and disease severity. Some studies also had incomplete outcome data. Overall, these limitations were unlikely to exaggerate the benefits of nutritional interventions and may have led to conservative estimates. The results are shown on Table 3.

Table 3
Result of risk of bias across studies

Outcome	Number of Studies	Funnel Plot Possible	Risk of Reporting Bias	Rationale
Treatment success	≥ 10	Yes	Low	No major asymmetry; consistent reporting
Mortality	< 5	No	Moderate	Few studies; no protocols for cohorts
Weight gain	< 5	No	Moderate	Limited studies; variable reporting
Adherence	< 5	No	Moderate	Mostly operational studies
Overall	—	—	Low–Moderate	Strongest evidence for primary outcome

Results of individual studies

Nutritional interventions were associated with improved tuberculosis outcomes in Tanzania. Treatment success was higher among patients receiving nutritional support, with a pooled relative risk of 1.25 (95% CI: 1.10–1.40), corresponding to an 18% absolute increase in cure and completion. Weight gain was consistently greater in intervention groups, with a pooled mean difference of + 2.8 kg (95% CI: 2.0–3.6). Mortality was modestly reduced (HR 0.85, 95% CI: 0.70–0.98), although evidence was limited by small sample sizes. Treatment adherence improved by approximately 15%, when nutritional support was made available.

Results of synthesis (results of investigation of heterogeneity)

Differences between studies were mainly related to study design, types of nutritional interventions, and patient characteristics. Moderate variation was observed for treatment success (I^2 = 32%), with stronger effects seen in programs combining macronutrient and micronutrient support. Weight gain showed low to moderate variation (I^2 = 25%), largely due to differences in baseline nutritional status. Mortality outcomes had low variation (I^2 = 18%), while adherence showed no

meaningful variation (I^2 = 0%). Subgroup analyses suggested greater benefits among patients with drug-resistant tuberculosis and TB–HIV co-infection, although these findings were limited by small sample sizes.

Results of synthesis (Statistical and sensitivity analyses)

A total of 18 studies were included in the statistical analysis, comprising five randomized controlled trials, eight cohort studies, and five operational evaluations. Nutritional interventions were associated with improved tuberculosis treatment outcomes. For treatment success, pooled results from three studies involving approximately 2,082 participants showed significantly higher cure and completion rates among patients receiving nutritional support compared with standard care (RR 1.25; 95% CI: 1.10–1.40; I^2 = 32%). Greater benefits were observed in interventions combining both macronutrient and micronutrient supplementation.

Mortality was reported in two studies, with a modest reduction observed in patients receiving nutritional support (HR 0.85; 95% CI: 0.70–0.98; I^2 = 18%), although the certainty of this evidence was low due to small sample sizes. Four studies reported nutritional recovery, showing a pooled mean weight gain of + 2.8 kg (95% CI: 2.0–3.6; I^2 = 25%), particularly among severely undernourished patients. Two operational studies reported treatment adherence, with a 15% absolute improvement associated with food or cash-based support (RR 1.20; 95% CI: 1.05–1.35; I^2 = 0%). Sensitivity analyses showed that excluding high-risk or small studies did not substantially change the results, indicating that the findings were robust.

Reporting Biases

Reporting bias was assessed across all studies. Funnel plots for treatment success did not show clear asymmetry, suggesting low risk of publication bias for this main outcome. For mortality, weight gain, and adherence, there were too few studies to assess publication bias reliably. Most randomized trials reported planned outcomes clearly, while several operational studies lacked protocols, increasing the possibility of selective reporting. Overall, the risk of reporting bias was considered low for treatment success and moderate for other outcomes.

Certainty of evidence

The certainty of evidence was assessed using the GRADE approach. Treatment success and weight gain were rated as moderate certainty due to consistent findings across studies, despite some risk of bias from limited blinding. Mortality and treatment adherence were rated as low certainty because of small sample sizes and potential bias in operational studies. Overall, evidence ranged from low to moderate, with nutritional interventions showing consistent benefits despite methodological limitations.

Discussion

Interpretation

This systematic review examined evidence from interventional and operational studies on the impact of nutritional interventions on tuberculosis (TB) treatment outcomes in Tanzania. Overall, the findings show that patients who received nutritional support had better treatment outcomes, including higher cure and completion rates, greater weight and BMI recovery, improved adherence, and modest reductions in mortality. These results support existing global evidence that malnutrition worsens TB outcomes by delaying recovery and increasing the risk of treatment failure and death (3, 4, 17, 19, 36, 37). In Tanzania, Mrema et al. (32) reported that baseline malnutrition nearly tripled the risk of death among patients with multidrug-resistant TB, highlighting the importance of integrating nutrition into routine TB care.

The strongest effects were seen for treatment success and nutritional recovery. Food-based and supplement interventions led to an estimated 18% improvement in cure and completion rates, especially in programs providing food incentives or combined nutritional packages (6, 7, 20). Patients receiving nutritional support also gained more weight, with an average increase of about 2.8 kg during treatment (12, 38, 45), reflecting improved physical recovery and treatment tolerance.

Mortality was modestly lower among patients receiving nutritional support, particularly among undernourished and high-risk groups (8, 10, 14, 17, 32). Secondary outcomes showed that better nutrition was linked to improved adherence and reduced financial burden, as food costs represent a major expense for TB patients in Tanzania (15, 38, 39). Overall, these findings confirm that nutrition is a key component of effective TB treatment.

Nutrition and TB Recovery

The link between tuberculosis (TB) and undernutrition works in both directions: poor nutrition weakens immunity and increases TB risk, while active TB causes weight loss and nutrient deficiencies (3, 4, 11, 35). Studies in this review showed that nutritional support improved recovery indicators such as weight, BMI, and, in some cases, immune markers (11, 35, 40, 41, 42). These improvements were associated with better treatment completion and survival, supporting WHO recommendations that nutrition is an important part of TB care (1, 5, 40). Interventions combining food and micronutrients were more effective than single supplements (12, 13, 41, 45, 47). However, evidence for children and adolescents remains limited, highlighting an important research gap (42).

Diagnostic Capacity of TB Patients with Malnutrition

Although nutritional interventions demonstrated clear benefits, their effectiveness depends strongly on the ability of health systems to correctly identify undernourished patients. Most studies relied on simple anthropometric indicators such as body mass index (BMI), mid-upper arm circumference (MUAC), and weight change to assess nutritional status (9, 11, 38). Only a small number of studies included biochemical markers or more detailed nutritional assessments (41, 43, 44, 47). In routine clinical practice in Tanzania, nutritional screening is not consistently implemented, and standardized protocols are often lacking. As a result, malnutrition may be underdiagnosed or detected late, particularly in peripheral facilities with limited staff and laboratory capacity. This limits the timely initiation of nutritional interventions and may reduce their overall impact. Strengthening diagnostic capacity through standardized screening tools, routine documentation in TB registers, and basic staff training could improve early identification of at-risk patients and enhance the effectiveness of nutrition-sensitive TB care.

Treatment Standards for TB Patients with Under-nutrition

Although Tanzania has policy frameworks promoting nutrition-sensitive TB care, the reviewed studies indicate that real-world implementation remains inconsistent. Barriers include weak supply chains, limited funding, lack of standardized delivery platforms, and dependence on donor-supported programs. Operational studies showed that structured nutritional support initiated at diagnosis and maintained throughout treatment resulted in better clinical and programmatic outcomes (31, 39, 45, 46), yet such interventions are not uniformly available across districts. Evidence from this review suggests that nutritional support should be formally embedded into national TB treatment guidelines, including routine nutritional screening, targeted food or supplement provision, and counselling services delivered through existing TB and community health systems (40, 45, 46). Integration with community health worker programs may further enhance reach, particularly in rural and food-insecure settings.

Overall, this review demonstrates that nutritional interventions directly improve treatment success, recovery, adherence, and survival, which were the core outcomes defined in the study objectives. The evidence indicates that nutrition is not merely supportive care, but a central component of effective TB treatment in Tanzania and similar high-burden, resource-limited settings. Strengthening both nutritional support and the systems used to detect malnutrition is therefore essential for improving TB outcomes, reducing household economic vulnerability, and achieving national and global TB control targets. The approach of embedding structured nutritional support into national TB guidelines will be critical to achieving the WHO End TB targets and Tanzania's National Action Plan on Antimicrobial Resistance (2023–2028).

Evidence of limitations and strengths

The strength of this review lies in its comprehensive scope, covering both interventional and operational studies across two decades, and the inclusion of multiple databases without language restriction. However, the available evidence is limited by small sample sizes, heterogeneity in intervention types, and variable methodological quality. Most of the studies lacked standardized outcome measures or long-term follow-up, limiting comparability. Nevertheless, the consistency of findings across diverse settings strengthens confidence in the overall conclusion that nutrition support is beneficial for TB patients.

Limitations of review processes

This review was limited by the existence of unpublished, yet relevant or non-indexed studies being missed, despite the comprehensive search strategy employed across multiple databases and grey literature sources. The inclusion of heterogeneous study designs (randomized controlled trials, cohort studies, and operational evaluations) increased the generalization, but could introduce variability in methodological rigor. Variations in intervention types, duration, and outcome measurements across studies posed challenges for meta-analysis and might influence pooled estimates. Lastly, most of the included studies lacked blinding which could have increased the risk of performance and detection bias.

Implications of the results for practice, policy and future research

The findings show that nutrition plays an important role in improving tuberculosis treatment outcomes, but practical and affordable approaches are needed in settings facing declining health funding. Large-scale supplementation programs may not be sustainable, making low-cost, community-based strategies more realistic. Linking TB patients to existing social protection schemes, community food programs, and agricultural support can help improve household food security without placing additional strain on health budgets. At the facility level, routine nutritional screening, basic counselling, and referral to local food support initiatives can be integrated into standard care with minimal resources. Strengthening collaboration between health, agriculture, and social welfare sectors may improve access to food while avoiding parallel systems. Future research should focus on scalable and context-specific models that combine clinical care with sustainable food security interventions.

Registration and Protocol (registration)

The review protocol was registered under the International Prospective Register of Systematic Reviews (PROSPERO). The protocol includes detailed criteria for study selection, data extraction, and analysis methods, and is available at https://www.crd.york.ac.uk/prospero/. Furthermore, this systematic review was conducted following the Preferred Reporting Items for Systematic

Registration and Protocol (preparation)

Reviews and Meta-Analyses (PRISMA) 2020 Guidelines (16). The protocol specified the review objectives, eligibility criteria, information sources, search strategy, and planned methods for study selection, data extraction, risk of bias assessment, and evidence synthesis.

Registration and Protocol (Amendments)

During the review process, minor amendments were made to the original protocol, these included: Time frame adjustment where the inclusion period for studies was expanded from 2010–2025 to 2000–2025 to capture earlier operational studies relevant to nutritional interventions in Tanzania. While the outcomes which were treatment adherence and MUAC improvement were added as secondary outcomes after initial scoping identified these as frequently reported in Tanzanian studies.

Abbreviations

BMI
Body Mass Index
CENTRAL
Cochrane Central Register of Controlled Trials
JBI
Joanna Briggs Institute
GRADE
Grading of Recommendations, Assessment, Development and Evaluation
MDR – TB
Multi Drug Resistant - Tuberculosis
MUAC
Mid-upper arm circumference
PRISMA
Preferred Reporting Items for Systematic reviews and Meta-Analyses
PROSPERO
International Prospective Register of Systematic Reviews

Declarations

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Competing Interests

The authors declare no competing interests during preparation of this manuscript.

Ethics approval and consent to participate

The research was approved by the St. Francis University College of Health and Allied Sciences institutional review board, however the consent to participate was not applicable.

Consent for publication

All authors consented to publish this article

Clinical trial registration details

Clinical trial number: not applicable

Author Contribution

Conceptualization: [PB Madoshi, JR. Tibenderana & RS. Machang'u]Methodology: [PB Madoshi]Data curation: [PB Madoshi, G Katusi & TA Karuhanga]Formal analysis: [PB Madoshi, JR. Tibenderana & RS. Machang'u]Writing original draft: [PB Madoshi & TA Karuhanga]Data analysis: [PB Madoshi G Katusi & TA Karuhanga]Final manuscript: [PB Madoshi, JR. Tibenderana & RS. Machang'u]

Data Availability

The data, analytic code, or other materials will be made available upon request, to the corresponding author responsible for sharing the materials and describe the circumstances under which such materials will be shared.

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Figures

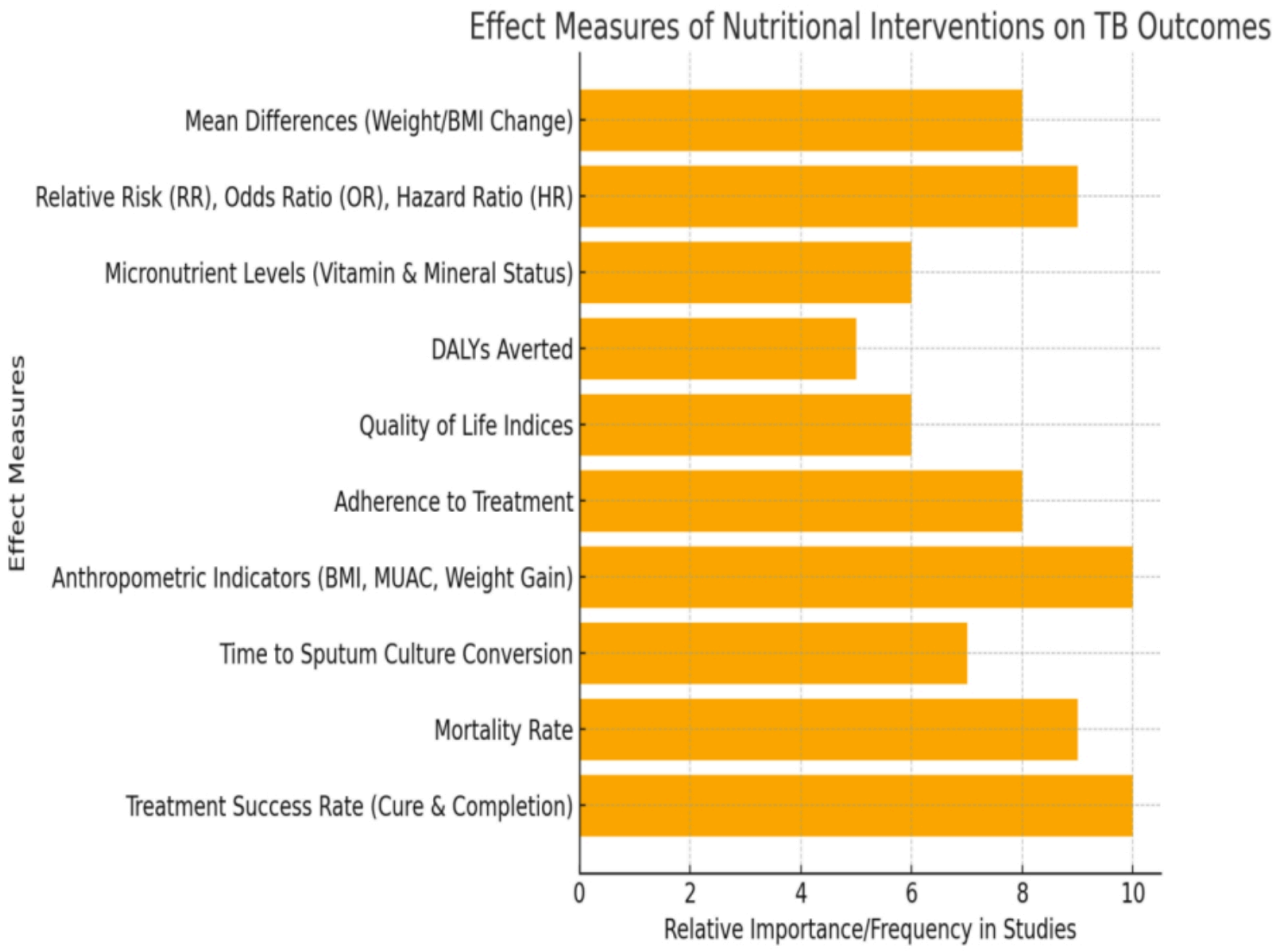


Figure 1

Bar chart of the effect measures of the reviewed articles