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Center for Nutrition Studies: Collaborative Action Report on National and Global Tuberculosis Frameworks (AY 2024–25)

(https://www.yenepoya.edu.in/center-of-nutrition-studies.php)

The Center for Nutrition Studies was established in 2017 to bring together specialists from various departments, including General Medicine and Community Medicine, alongside national and global experts to combat tuberculosis (TB) through improved nutrition. The Center was founded by Dr. Anurag Bhargava and is currently headed by Dr. Madhavi Bhargava, Professor in the Community Medicine Department at Yenepoya Medical College.

The Center undertook the RATIONS Trial with the sponsorship of the Indian Council of Medical Research (ICMR), Ministry of Health and Family Welfare, Government of India. This project was a landmark cluster-randomized controlled trial conducted in Jharkhand between 2019 and 2022 to evaluate the role of nutrition intervention improving the outcomes in patients with active TB and its role in prevention of new TB in household contacts who are at risk of TB. The study demonstrated that by providing nutritional support to active TB patients and their household contacts, results in a significant reduction in patient mortality and new TB cases within households which was as good as current available TB vaccines (Cited in Reference Section).

This report summarises how the Center for Nutrition Studies used its extensive field research dataset from the RATIONS Trial to support national and global health policy and practice development during AY 2024–25.

1. National and International collaboration for measuring tuberculosis data

The Centre collaborated with the TB Modelling Group and the Centre for Mathematical Modelling of Infectious Diseases at the London School of Hygiene & Tropical Medicine for embedding empirical field data into their compartmental transmission models to project national disease incidence, mortality, and cost-effectiveness scenarios across India up to 2035. The collaboration also involved National Institute for Research in Tuberculosis, ICMR, Govt. of India. This extensive data measurement and disease modelling work culminated in a co-authored joint study published in *The Lancet Global Health* (January 2025) copy of which is attached in the **Annexure 1**.

2. Development of international best practice for tackling tuberculosis

The Center has co-developed the *Nutrition and Tuberculosis* course in collaboration with the McGill Summer Institutes in Global Health, Canada, to implement standardized international best practices for integrating nutrition support into standard disease. The first edition of the course was delivered in May and the Second Edition in May 2025. The target audience for the course includes students of global health, medicine, clinicians, nurses, national TB program managers, researchers, nutrition professionals, and civil society champions, with enrolment intentionally limited to 60 participants to ensure high-impact, interactive professional development. The Center's

contribution to this global training platform was coordinated directly by the center head, Dr. Madhavi Bhargava. The course brochures are attached in **Annexure 2.**

3. Contribution to national government health policy development

The Centre Head was invited to present the tuberculosis modeling work mentioned in section (1) at the consultation meeting on *Strengthening TB Nutrition Research in India*, organized by ICMR and the Gates Foundation. As ICMR functions under the Department of Health Research, Ministry of Health and Family Welfare, Government of India, this engagement provided a platform for presenting the university's research findings within a national government-linked consultation on TB and nutrition research. Copies of the invitation and schedule with objective of the consultation meeting are given **Annexure 3**.

List of Annexures:

Annexure 1: Copy of the disease modelling work in collaboration with international and national government organizations.

Annexure 2: Course brochures

Annexure 3: Copies of invitation and schedule of the consultation meeting

Prepared by: Head, Center for Nutrition Studies ..... Madhavi ..... Date 16.10.25

Submitted to: Internal Quality Assurance Cell ..... Date 16.10.25

References:

1. *Bhargava A, Bhargava M, Meher A, et al. Nutritional supplementation to prevent tuberculosis incidence in household contacts of patients with pulmonary tuberculosis in India (RATIONS): a field-based, open-label, cluster-randomized, controlled trial. Lancet. 2023 Aug 8:S0140-6736(23)01231-X.*
2. *Bhargava A, Bhargava M, Meher A, et al. Nutritional support for adult patients with microbiologically confirmed pulmonary tuberculosis: outcomes in a programmatic cohort nested within the RATIONS trial in Jharkhand, India.* Lancet Glob Health. 2023 Aug 7:S2214-109X(23)00324-8.

Annexure-1

Estimating the epidemiological and economic impact of providing nutritional care for tuberculosis-affected households across India: a modelling study

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Summary

Background Approximately 20% of global tuberculosis incidence is attributable to undernutrition, increasing to more than a third in India. Targeting nutritional interventions to tuberculosis-affected households is a policy priority, but understanding of epidemiological and economic impacts is limited. We aimed to estimate the population-level epidemiological and economic effect of such an intervention.

Methods We used a previously published, age-stratified, compartmental transmission model of tuberculosis in India, and incorporated explicit BMI strata linked to disease progression and treatment outcomes. We used results from a recent trial of an intervention in which nutritional support in the form of food baskets was provided to people initiating tuberculosis treatment and to their household contacts (1200 kcal for patients and 750 kcal for contacts) to inform estimates of the impact and costs of nutritional support. We estimated the numbers of cases of tuberculosis disease and deaths due to tuberculosis disease that could be averted from 2023 to 2035 under the intervention scenario.

Findings Compared with a baseline with no nutritional intervention, at 50% coverage of adults on tuberculosis treatment and their households (around 23% of households affected by incident tuberculosis in India), providing the nutritional support intervention could prevent 361 200 (95% uncertainty interval 318 000–437 700) tuberculosis deaths and 880 700 (802 700–974 900) disease episodes from 2023 to 2035. This would be equivalent to averting approximately 4·6% (4·2–5·5) tuberculosis deaths and 2·2% (2·1–2·4) tuberculosis episodes. The additional health system cost would be US$1349 million (1221–1492), with an incremental cost-effectiveness ratio of $167 (147–187) per disability-adjusted life-year averted. The median number of households needed to treat to prevent one tuberculosis death was 24·4 and to prevent one tuberculosis case was 10·0.

Interpretation A nutritional intervention for tuberculosis-affected households could avert a substantial amount of tuberculosis disease and death in India, and would be highly likely to be cost-effective on the basis of the tuberculosis-specific benefits alone.

Funding None.

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Introduction

Globally, tuberculosis disease remains one of the leading causes of mortality due to a single pathogen. Exposure to *Mycobacterium tuberculosis* is widespread in countries with a high tuberculosis burden; however, most individuals contain or clear their infection.[1] Comorbidities such as HIV, diabetes, and undernutrition can impair the control of *M tuberculosis*, increasing the risk of progressing to disease[2] and unfavourable outcomes.[3] Undernutrition is the leading risk factor for tuberculosis globally, accounting for 20% of annual tuberculosis incidence, and is a leading comorbidity in patients with tuberculosis.[1] In recent years, the number of people with food insecurity has increased globally, highlighting the urgent need to incorporate nutritional interventions into tuberculosis elimination efforts.

Ecological observations and evidence from well documented cohorts have supported the benefit of improved nutrition in the decline of tuberculosis incidence in countries that now have a low tuberculosis burden.[4] Despite insufficient research on the effect of nutritional interventions on treatment outcomes,[5] in 2013, WHO recommended nutritional assessment, counselling, and support in selected groups as integral components of tuberculosis care.[6] Globally, programmatic implementation of this recommendation is sparse;[7] however, in India, the tuberculosis elimination programme established a direct benefit transfer in 2018 to enable a nutritious diet.[8] The recent RATIONS cluster-randomised controlled trial in the Indian state of Jharkhand—a setting with high prevalence of poverty, undernutrition, and tuberculosis—showed for the first time evidence of the effect of a macronutritional support

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For the Bangla translation of the abstract see Online for appendix 1

For the Hindi translation of the abstract see Online for appendix 2

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Research in context

Evidence before this study

We searched PubMed with the terms ("tuberculosis" OR "tubercul*") AND ("nutrition*" OR "nutrient*" OR "diet*" OR "vitamin*") AND ("household") AND ("model*" OR "cost-effect*") for articles published from database inception to May 30, 2024, in English. We found 55 studies, from which we identified two studies that had estimated the cost-effectiveness of nutritional supplementation. One modelling study estimated the potential impact of nutritional interventions, including at a household level. One cluster-randomised controlled trial estimated the number needed to treat to prevent tuberculosis incidence. A 2022 study by Sinha and colleagues used a Markov model from the provider perspective to estimate the effect of providing nutritional support to undernourished individuals in India, finding that a substantial burden of tuberculosis in this population could be averted through this likely cost-effective intervention. Focusing on undernutrition in household contacts alone had a lower incremental cost-effectiveness ratio (ICER) than the general population. In a 2024 study (preprint), Sinha and colleagues took a similar approach again in India but considered household contacts in general, and also found this intervention to be cost-effective at most willingness-to-pay thresholds. Mandal and colleagues used a transmission model to estimate the epidemiological effect of providing nutritional support to undernourished household contacts of patients with tuberculosis across the southeast Asian region, finding a sizeable proportion of tuberculosis could be averted. Meanwhile, Bhargava and colleagues (2023) showed in a trial of nutritional supplements in India that around 30 households needed to receive the intervention to prevent one case of incident tuberculosis in 2 years.

Added value of this study

Our study is the first to evaluate the impact and cost-effectiveness of a nutritional intervention for tuberculosis-affected households while considering the effect on onward transmission of reduced tuberculosis disease. We compared different recipients of the intervention (both individuals on tuberculosis treatment and their household contacts), providing national-level estimates of the health benefits, costs to both the health system and to wider society, and ICERs for India.

Implications of all the available evidence

We found that if India can deliver a nutritional intervention to 50% of households in which individuals are receiving tuberculosis treatment, nearly 900 000 episodes of tuberculosis would be averted, and nearly 400 000 deaths, at a cost of $167 per disability-adjusted life-year averted. Nutritional supplementation is likely to have substantial tuberculosis-related health benefits and be cost-effective at most willingness-to-pay thresholds, even at the national level. A focus on states with high levels of undernutrition is likely to avert a higher proportion of the tuberculosis burden, further improving the value for money. Considering the equity and health benefits beyond tuberculosis, our study likely underestimates both impact and cost-effectiveness.

intervention in reducing tuberculosis incidence in the household contacts of adult patients with tuberculosis,[9] as well as improving treatment outcomes for the patients themselves.[10]

In this study, we modelled the effect of scaling up such an intervention nationally in India to estimate the potential impact of the intervention on tuberculosis incidence and mortality in the longer term, including averted transmission, as well as the cost and cost-effectiveness of introducing nutritional support to those receiving tuberculosis treatment and their household contacts.

Methods

Model

We used a previously published, age-stratified, compartmental transmission model of tuberculosis in India.[11] The methods are reproduced here with modifications described to simulate the intervention, and are visualised in appendix 3 (p 2). The model was coded in R version 4.3.3 and 4.3.2.

See Online for appendix 3

We incorporated explicit BMI strata into the model (<17·0 kg/m², 17·0 kg/m² to <18·5 kg/m², 18·5 kg/m² to <25·0 kg/m², and ≥25·0 kg/m²). Trends in BMI were obtained from the UN Population Division (2019 revision),[12] the Global Health Observatory,[13] and India National Family Health Surveys,[14] and future BMI projections were obtained from the LandSyMM food system model middle-of-the-road scenario.[15] We used weight-for-height SDs for children younger than 5 years and BMI SDs for children and adolescents aged 5–19 years. We re-estimated the relative BMI-specific risk of progression and reversion to tuberculosis disease (similar to methods used elsewhere)[2,16] and treatment outcomes[3] (appendix 3 p 8). The risk of *M tuberculosis* infection[17] and time to diagnosis were assumed to be the same across BMI strata.

Calibration and uncertainty

The model was fitted to 15 calibration targets to represent the tuberculosis epidemic in India: the tuberculosis incidence, mortality, and case notification rates (overall and by age) in the calendar years 2000 and 2020,[1] the tuberculosis disease prevalence (overall and for adults) in 2015 and in 2021,[18,19] the overall prevalence of *M tuberculosis* infection (not including current tuberculosis disease) in 2021,[18] and the fraction of asymptomatic tuberculosis among active tuberculosis disease.[20] The effect of the COVID-19 pandemic was thus implicitly included (because the case notification and

prevalence data overlapped with the pandemic period) in our calibration process. The model was calibrated using history matching with emulation and an approximate Bayesian computation Markov chain Monte Carlo method (appendix 3 p 11).[21] We validated our calibration by comparing estimates of population attributable fraction due to undernutrition from our model to recent estimates.[1,22]

We calibrated 1000 parameter sets, which we used with the mechanistic tuberculosis model to simulate the future and to quantify the uncertainty in tuberculosis natural history (eg, risks of *M tuberculosis* infection and progression to disease) based on previously published literature (appendix 3 p 5).

Intervention scenarios

The RATIONS trial saw the provision of food baskets (1200 kcal for patients with tuberculosis and 750 kcal for household contacts), alongside micronutrient supplements, to adults on tuberculosis treatment and their household contacts.[9,10] We considered seven intervention scenarios; this included four mechanisms of action of such a nutritional support intervention (two affecting people with tuberculosis on treatment and two affecting household contacts), a combined scenario of both mechanisms for people with tuberculosis on treatment, a combined scenario of both mechanisms for household contacts, and a combined scenario including all four mechanisms for both people with tuberculosis on treatment and household contacts. Based on the outcomes recorded in the trial, the four mechanisms were as follows: (1) improvements in treatment outcomes for people with tuberculosis on treatment; (2) improvements in BMI for people with tuberculosis on treatment; (3) reductions in tuberculosis disease incidence for household contacts; and (4) improvements in BMI for household contacts. We assumed that improvements in BMI lasted for 2 years. We assumed instant scale-up of the intervention to reach 50% of the adult population (to align with the trial, which enrolled both child and adult household contacts of adult index patients) notified and started on treatment each year from 2023 to 2035, and did not separate public versus private health-care facilities (which can differ in terms of treatment initiation rates, drug susceptibility testing, and treatment outcomes). We assumed that the coverage and quality of existing interventions in the tuberculosis programme remained constant, including coverage of the existing direct benefits transfer scheme, which was implicitly considered in the epidemiological dynamics (due to an absence of efficacy data to do so explicitly).

For improvements in treatment outcomes for people with tuberculosis, the trial did not include a comparator group. We therefore assumed that those who received nutritional support had a reduced hazard of death of 0·67 relative to those who did not receive nutritional support (where the probability of death on treatment was dependent on factors such as age and BMI). This assumption reflects a combination of the 54% of patients in the trial who had weight gain of at least 5% at 2 months, which was associated with a reduced hazard of death (adjusted hazard ratio [HR] 0·39, 95% uncertainty interval [UI] 0·18–0·86), and the remaining 46% of patients who we assumed had an unchanged hazard of death (ie, 1).[10]

Separately, for improvements in BMI for people with tuberculosis on treatment we assumed an increase in BMI in line with the trial[10] for a proportion of adults on treatment equivalent to the intervention coverage.

For reductions in tuberculosis disease incidence for household contacts, we estimated the number of household contacts (both children and adults) who were expected to develop tuberculosis disease, and reduced this using the trial incident rate ratio (IRR). We estimated the number at risk using the number of households receiving the intervention, the mean household size minus one (the person with tuberculosis on treatment),[14] and the proportion of those who would be expected to develop tuberculosis disease (3419 [95% UI 1569–5132] per 100 000 population [based on a previous review[23] using the first 3 years for low-income and middle-income countries only]). We multiplied the number of people at risk by the protective effect of the trial (0·39 [ie, 1–0·61]) to identify those who would have gone on to develop tuberculosis disease in the absence of the intervention, and assumed that they remained infected with *M tuberculosis* only.

For improvements in BMI for household contacts we assumed an increase in BMI in household contacts (both adults and children) in line with the trial.[9] However, household contacts are at an increased risk of tuberculosis disease.[23] We therefore assumed that 3·1% (95% UI 2·2–4·4) of contacts would have tuberculosis disease, and used the estimated number of household contacts and the intervention coverage to increase the BMI of those with disease in the household.[23] We then assumed that the remaining contacts had the same BMI distribution (and distribution of *M tuberculosis* infection status other than disease) as the general population, which we again increased in line with the trial results. We assumed a similar increase in weight-for-height and BMI for children and adolescents. We did not consider the impact of tuberculosis screening for existing tuberculosis disease among household contacts.

Costs

We assumed tuberculosis diagnostic and treatment costs from the health system perspective per patient and episode in previous work.[11] In addition, from the societal perspective, we accounted for indirect and non-medical patient costs, including productivity loss and transportation while receiving treatment. We assumed a total intervention cost (cost of food basket and delivery) per person receiving tuberculosis treatment of US$92·02, and $33·23

per household contact, based on the cost per month reported in the trial[9] and assuming 6 months of treatment. Further details are included in appendix 3 (p 16).

Outcomes

We estimated tuberculosis incidence, mortality rates, and the number of people developing tuberculosis disease and dying due to tuberculosis for each year from 2023 to 2035 for each of the scenarios. For each scenario, we calculated the total tuberculosis costs from the health system and societal perspectives, including indirect and non-medical costs, and the total savings compared with the no-intervention scenario. We discounted both costs and outcomes to 2023 at 3% per year. We calculated the difference in total disability-adjusted life-years (DALYs) from each scenario compared with a scenario with no intervention. For individuals currently with tuberculosis, we used the disability weight (used to weight the magnitude of health loss due to a specific health state, such as tuberculosis disease) from the Global Burden of Diseases, Injuries, and Risk Factors Study 2019 of 0·333 (95% UI 0·224–0·454),[24] and age-specific life expectancy estimates from the UNDP[25] to estimate years lived with a disability. We did not incorporate any disability weights for different BMI categories.

We did cost-effectiveness analyses for scenarios delivering the intervention to different groups (those receiving tuberculosis treatment, household contacts of those receiving tuberculosis treatment, or both) and compared incremental cost-effectiveness ratios (ICERs) against three willingness-to-pay thresholds (cost per DALY averted): 1×gross domestic product (GDP) per capita ($2411 in 2022),[26] and two India-specific cost thresholds[27] (upper [$555] and lower [$410] bounds, representing 23% and 17% of GDP per capita, respectively).

Sensitivity analyses

We varied the duration of protection in our model (ie, how long individuals had an improved BMI or treatment outcome for), comparing whether they returned to their previous state immediately after treatment; remained in an improved state for a mean of 1 year, waning exponentially; remained in an improved state for a mean of 5 years; or remained in an improved state for life.

Separately, we varied the coverage of the intervention, assuming the intervention reached either 20% or 80% of the adult population on treatment each year from 2023 to 2035.

Finally, we varied the intervention impact by BMI status, comparing whether the adjusted HR was higher in those with a low BMI; whether the protective effect of the trial in terms of an IRR for household contacts varied by BMI status as in the trial (where those with a normal BMI had a larger reduced IRR than those who were underweight); or whether both the adjusted HR and the IRR varied by BMI status.

	No intervention	Intervention						
		Given only to adult patients with tuberculosis			Given only to household contacts			Full intervention§
		Improved outcomes*	Improved BMI†	Combined*†	Reduced incidence‡	Improved BMI†	Combined†‡	
Total outcomes								
Incident tuberculosis in 2035, per 100 000 population	157·6 (141·2 to 174·6)	158·0 (141·5 to 175·1)	156·8 (140·5 to 173·5)	157·2 (140·8 to 173·9)	152·6 (136·4 to 169·1)	157·2 (140·8 to 174·1)	152·1 (136·1 to 168·6)	151·6 (135·7 to 168·0)
Tuberculosis deaths in 2035, per 100 000 population	30·5 (27·9 to 33·8)	29·6 (27·1 to 32·8)	30·1 (27·6 to 33·4)	29·3 (26·8 to 32·4)	29·6 (27·0 to 32·8)	30·4 (27·9 to 33·7)	29·5 (27·0 to 32·7)	28·3 (25·9 to 31·4)
DALYs incurred, millions	2212 (2207 to 2218)	2208 (2203 to 2215)	2211 (2206 to 2217)	2207 (2202 to 2214)	2209 (2204 to 2215)	2212 (2207 to 2218)	2209 (2204 to 2215)	2204 (2199 to 2210)
Outcomes averted								
Additional cumulative incident tuberculosis, thousands	..	−42·1 (−65·2 to −32·0)	84·2 (66·7 to 121·1)	46·7 (27·8 to 71·6)	777·1 (718·0 to 850·7)	59·2 (51·0 to 69·3)	833·7 (768·7 to 917·3)	880·7 (802·7 to 974·9)
Additional cumulative incident tuberculosis, %	..	−0·1% (−0·2 to −0·1)	0·2% (0·2 to 0·3)	0·1% (0·1 to 0·2)	2·0% (1·8 to 2·1)	0·2% (0·1 to 0·2)	2·1% (2·0 to 2·3)	2·2% (2·1 to 2·4)
Additional cumulative tuberculosis deaths, thousands	..	184·3 (148·8 to 242·4)	59·4 (47·1 to 80·8)	234·3 (193·7 to 305·7)	120·5 (108·9 to 133·8)	8·9 (7·9 to 10·2)	129·2 (116·9 to 143·1)	361·2 (318·0 to 437·7)
Additional cumulative tuberculosis deaths, %	..	2·4% (1·9 to 3·1)	0·8% (0·6 to 1·0)	3·0% (2·6 to 4·0)	1·5% (1·4 to 1·7)	0·1% (0·1 to 0·1)	1·7% (1·5 to 1·8)	4·6% (4·2 to 5·5)
DALYs averted, millions	..	3·7 (2·9 to 4·8)	1·3 (1·0 to 1·6)	4·8 (3·9 to 6·0)	3·1 (2·8 to 3·5)	0·2 (0·1 to 0·2)	3·4 (3·0 to 3·7)	8·0 (7·1 to 9·4)

Values in parentheses are 95% uncertainty intervals. DALYs=disability-adjusted life-years. *Patients with tuberculosis who received the intervention have improved treatment outcomes (a reduced hazard of death compared with patients with tuberculosis who do not receive the intervention). †Those receiving the intervention have an increased BMI compared with those who do not receive the intervention. ‡Household contacts receiving the intervention have a reduced incidence rate ratio for developing tuberculosis disease (ie, they are less likely to progress to tuberculosis disease than household contacts who do not receive the intervention). §Given to all individuals in tuberculosis-affected households, assuming the intervention effect has a combined effect of improved outcomes, reduced incidence, and improved BMI.

Table 1: Health outcomes for nutritional support interventions with 50% coverage of adults receiving tuberculosis treatment in India between 2023 and 2035, assuming 2-year duration of protection

Role of the funding source
There was no funding source for this study.

Results

If nutritional support is provided to 50% of adults notified and started on tuberculosis treatment in India and their household contacts between 2023 and 2035 (ie, the full intervention scenario), we project that a cumulative 880700 (95% UI 802700–974900) fewer people would develop tuberculosis disease and 361200 (318000–437700) fewer deaths would occur as a result (table 1). These values are equivalent to averting 2·2% (2·1–2·4) of all cases of tuberculosis disease and 4·6% (4·2–5·5) of all tuberculosis deaths (figure 1). This effect scales linearly with coverage: at 80% coverage, as many as 1396800 (1273700–1545400) fewer people would develop tuberculosis and 570900 (502300–691400) fewer would die (full results by coverage level are provided in an online repository). Providing nutritional support only to adult patients on tuberculosis treatment with 50% coverage could prevent 46700 (27800–71600) people developing disease, and 234300 (193700–305700) people dying as a result (table 1).

The duration of protection did not have a significant effect on our results; assuming that improvements in BMI (for both patients and their household contacts) and treatment outcomes would last only while the patient was on treatment reduced the overall effect of the intervention, while waning protection between 5 years and lifelong provided slightly improved outcomes (appendix 3 p 21). Varying the intervention impact by BMI status did not qualitatively change our results; varying the intervention effect on treatment outcomes by BMI reduces the number of tuberculosis deaths averted but makes very little difference to tuberculosis disease prevented, while varying the intervention effect on tuberculosis incidence in household contacts by BMI increases both the number of tuberculosis deaths averted and the number of tuberculosis disease episodes prevented (appendix 3 p 22).

Assuming 50% coverage of the full intervention, the median number of households that needed to receive the intervention to prevent one person developing tuberculosis disease was 10·0, and to prevent one person dying as a result was 24·4 (table 2). The number needed to treat remained stable irrespective of intervention coverage, with some variability due to model uncertainty (figure 2). Reducing the duration of protection increased the number needed to treat.

From a health system perspective, providing the nutritional support intervention only for patients with tuberculosis is likely to be cost-effective at most willingness-to-pay thresholds, with an ICER of $139 (95% UI 113–167) per DALY averted (table 2; figure 3) and total budget impact (additional health system cost) of $664 million (605–733; appendix 3 p 24). Compared with providing the intervention only to patients with

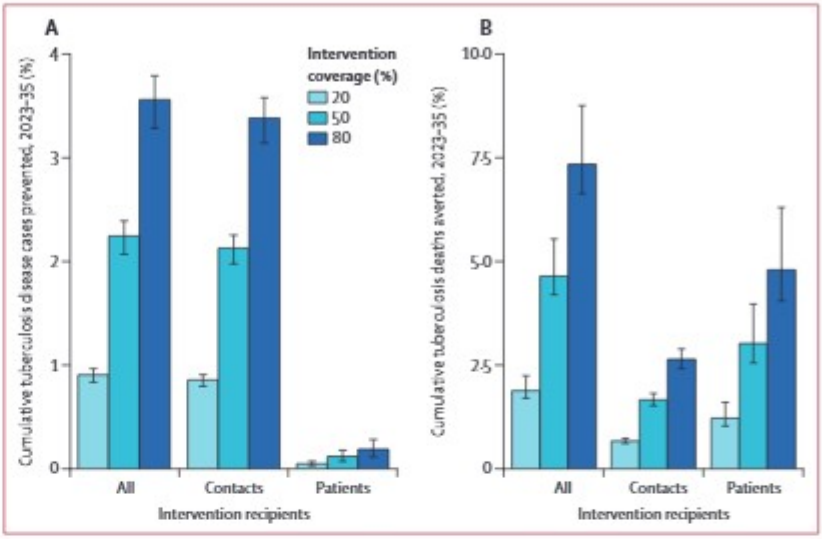


Figure 1: **Cumulative proportions of tuberculosis disease cases prevented (A) and deaths averted (B) due to a nutritional support intervention in India between 2023 and 2035, assuming 2 years duration of protection, and considering different recipients and coverage of the intervention**
Intervention recipients considered were all individuals in tuberculosis-affected households (all), only household contacts of people with tuberculosis (contacts), or only patients with tuberculosis (patients). Intervention coverage specifies the proportion of coverage among adults with tuberculosis receiving treatment.

	No intervention	Intervention		
		Given only to patients with tuberculosis	Given only to household contacts	Full intervention*
Total resources, US$ millions				
Average total health system cost	8618 (7990–9355)	9281 (8598–10093)	9313 (8624–10127)	9967 (9220–10846)
Average total societal cost	11967 (11096–12991)	12623 (11695–13719)	12610 (11677–13702)	13256 (12271–14417)
Additional resources required				
Additional health system cost†, US$ millions	--	664 (605–733)	696 (625–771)	1349 (1221–1492)
Additional societal cost†, US$ millions	--	656 (599–724)	643 (574–715)	1289 (1163–1426)
People with tuberculosis receiving support, thousands	--	8947 (8141–9937)	--	8829 (8033–9807)
Household contacts receiving support, thousands	--	--	30101 (27384–33450)	30018 (27312–33344)
Number of households needed to treat				
To avert one case of tuberculosis	--	191·6	10·6	10·0
To avert one death due to tuberculosis	--	38·2	68·5	24·4
Cost-effectiveness, US$ per DALY averted				
Incremental health system cost-effectiveness†	--	139 (113–167)	--	167 (147–187)
Incremental societal cost-effectiveness†	--	137 (112–164)	--	192 (166–218)

Values in parentheses are 95% uncertainty intervals. All costs are discounted at 3% per year. *Given to all individuals in tuberculosis-affected households. †Compared with no intervention.

Table 2: **Resources required for nutritional support interventions with 50% coverage of adults receiving tuberculosis treatment in India between 2023 and 2035, assuming 2-year duration of protection**

For the online repository of results see https://doi.org/10.5281/zenodo.14160778

tuberculosis, providing it additionally to household contacts of patients with tuberculosis is also likely to be cost-effective at most thresholds, with an ICER of $208 (181–234) per DALY averted and a budget impact of an additional $685 million (615–759 million). Both the intervention and treatment costs reduce over time. Compared with no intervention, provision of the full intervention has an ICER of $167 (147–187) per DALY averted, which remains consistent with increasing coverage. Results are qualitatively similar from a societal perspective (see online repository for full results).

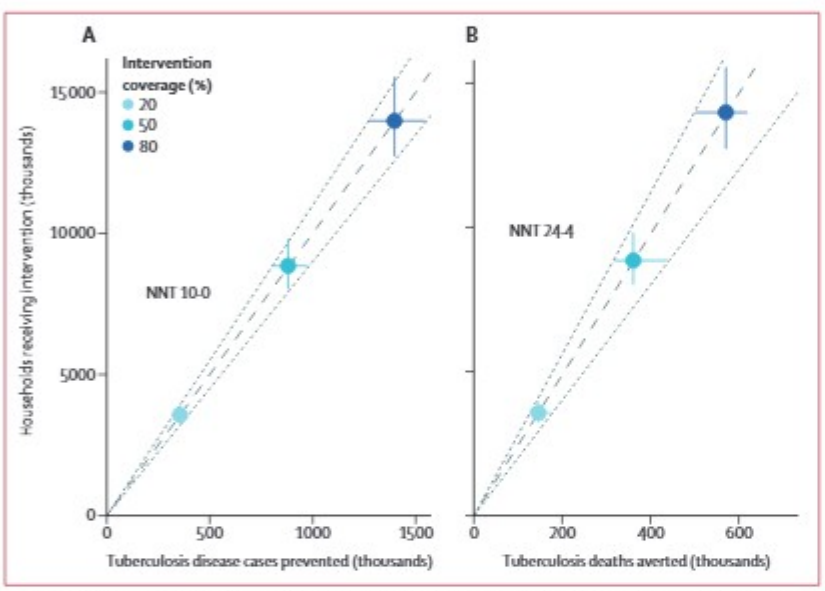


Figure 2: Number of households receiving the nutritional support intervention needed to prevent one person developing tuberculosis disease (A) and one tuberculosis death (B) in India between 2023 and 2035, with varying intervention coverage in adults on treatment

NNTs are shown for 50% coverage; for other coverage levels, NNTs were the same to this level of rounding. NNT=number needed to treat.

Discussion

Compared with a baseline with no nutritional intervention for patients with tuberculosis or their contacts, at 50% coverage of those on tuberculosis treatment (around 23% of incident tuberculosis-affected households), providing nutritional support to people with tuberculosis would prevent 234300 deaths due to tuberculosis in India between 2023 and 2035, and prevent 46700 people from developing the disease. Such an intervention would cost $664 million, with an ICER of $139 per DALY averted. Extending support to household contacts would prevent a total of 361200 tuberculosis deaths and 880700 cases of tuberculosis diseases, equivalent to averting 2·2% of all tuberculosis deaths and 4·6% cases of tuberculosis disease from 2023 to 2035. The additional cost would be $685 million, with an ICER of $208 per DALY averted. To prevent one person developing tuberculosis or one person dying from tuberculosis would require nutritional support under the full intervention scenario to 10·0 and 24·4 tuberculosis-affected households, respectively.

The effect of the intervention is constrained by two elements. First, the proportion of *M tuberculosis* transmissions that occur outside of the household, particularly in a setting with a high tuberculosis burden such as India, limits the amount of tuberculosis disease as well as subsequent tuberculosis deaths that can be prevented through reduced progression. Second, the proportion of tuberculosis deaths that occur in those who remain undiagnosed with tuberculosis disease limits the tuberculosis deaths that can be averted through improved

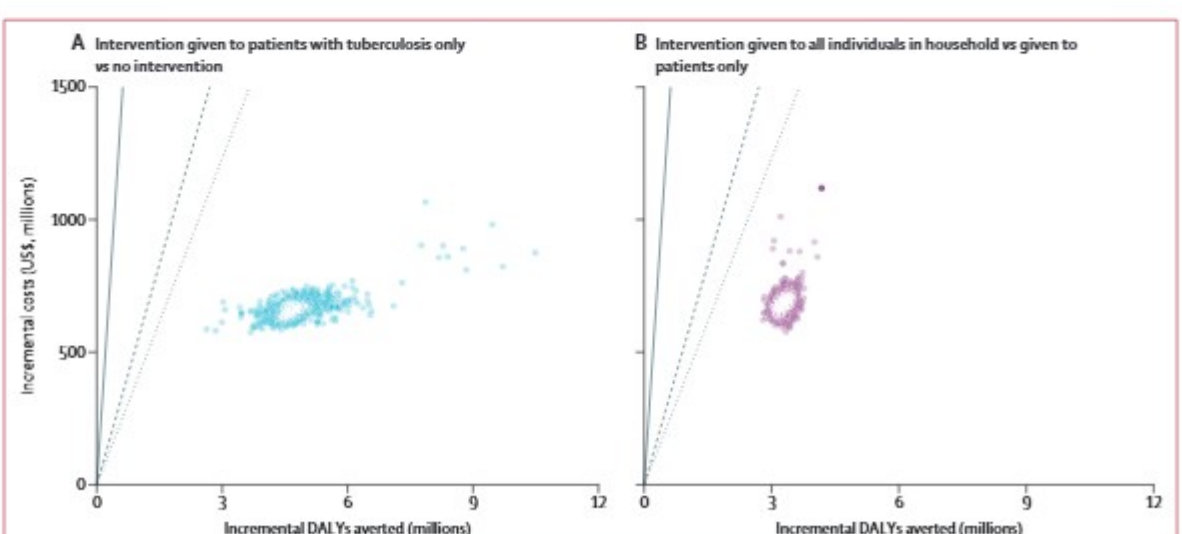


Figure 3: Incremental cost-effectiveness of the nutritional support intervention for patients with tuberculosis (A) and for patients and their household contacts (B) from a health system perspective at 50% coverage

Three willingness-to-pay thresholds are shown, based on 1×Indian GDP per capita in 2022 ($2411);[46] 23% of Indian GDP per capita ($555); and 17% of Indian GDP per capita ($410).[47] DALYs=disability-adjusted life-years. GDP=gross domestic product.

nutrition while on treatment. As a result, an intervention targeting only those on tuberculosis treatment and their households is able to avert a relatively low proportion of tuberculosis incidence and mortality, as compared with a population-level intervention to improve nutrition, which could have a substantially larger effect size (albeit with a much larger associated cost). By contrast, a nutritional intervention targeted towards those at highest risk, such as household contacts or those with undernutrition, particularly in a resource-constrained setting such as India, offers the opportunity to maximise cost-effectiveness within a feasible budget, improving population-level equity and allowing for a meaningful reduction in tuberculosis burden among those most susceptible to the disease. A targeted intervention in particular offers fewer resource allocation challenges, although the potential opportunity costs are important to consider within the context of wider programmatic activities.

The number needed to treat in our results was consistently substantially smaller than in the trial (30 households to prevent one incident case),[9] a result of future transmission averted in our model. The targeted nature of the intervention, focused on tuberculosis-affected households at a higher risk of both tuberculosis disease and poor outcomes, meant that the intervention was likely to see a much higher return for effort than a more general population-based intervention, and supports evidence of its cost-effectiveness. Our results showed that an intervention with 50% coverage of adult patients with tuberculosis and their households would avert around 2% of cumulative incidence between 2023 and 2035. This is similar in scale to estimates for a household-level intervention in a previous study,[28] which suggested an intervention improving BMI for all undernourished household contacts would see a 4·5% reduction in cumulative tuberculosis incidence and a 4·8% reduction in mortality between 2023 and 2035 given 100% coverage. Our results also showed a similar cost-effectiveness to that of recent studies, although somewhat improved due to additional transmission averted.[29]

Our model was limited by a number of assumptions for the intervention effect. A lack of comparator group for index patients in the trial means that we might have overestimated improvements in outcomes due to weight gain, which could also have occurred in part due to tuberculosis treatment.[3] Including both improvements in BMI and improvements in treatment outcomes might also lead to double-counting of the impact of the intervention effect, although the effect size of this is likely to be small. A lack of private treatment pathways in our model might have overestimated the achievable coverage of the intervention, and, similarly, our assumption of instant scale-up is highly optimistic, while other improvements in the programme over time would also reduce the potential intervention effect. We also did not explicitly consider drug-resistant tuberculosis in our analysis; notably, there is an urgent need for additional data in this area due to a higher prevalence of both undernutrition and poor treatment outcomes for drug-resistant tuberculosis.[1] On one hand, costs associated with the provision of nutritional support for a longer period (corresponding to the extended treatment period for drug-resistant tuberculosis, often around 9–24 months) will reduce the cost-effectiveness of the intervention. On the other hand, these costs will likely be more than offset by the additional cost-savings accrued with every drug-resistant tuberculosis treatment regimen averted.

By contrast, extending the intervention beyond adults on tuberculosis treatment to children and adolescents would increase the potential impact. Variation in both prices and implementation across the country could also lead to important regional differences not considered here, as well as indirect benefits to the community of sourcing food locally. It is also potentially problematic to generalise from the trial setting (a single Indian state with a high burden of both undernutrition and tuberculosis) to the country as a whole. However, when we varied the intervention effect by BMI status (which would to some extent account for regional differences in the burden of undernutrition), we saw a larger impact of the intervention, suggesting that our results are still likely to be valid. It would also be inadvisable to extrapolate our findings to individual states or regions only due to the wide variance in the burden of undernutrition and tuberculosis, as well as in access to health care and the relative importance of different settings of transmission. We also did not consider any potential case-finding component of the intervention, in which household contacts with prevalent tuberculosis might have been more likely to have been diagnosed due to the intervention (assuming good diagnostic performance), which would have increased the intervention effectiveness. Most importantly, however, we did not consider the wider, non-tuberculosis-specific benefits of the intervention and improvements in weight in tuberculosis-affected households, such as improved general health and ability to function, and reductions in post-tuberculosis lung damage. These benefits could potentially further increase the intervention impact and cost-effectiveness substantially.

The RATIONS study was the first adequately powered, randomised trial to assess the combined effects of macronutrient and micronutrient interventions on tuberculosis incidence, making it uniquely suited for parametrising our model. However, it is essential that further research in diverse contexts be conducted to confirm and validate these promising findings. To ensure maximal uptake, food baskets should be designed through community-engaged research, incorporating the dietary practices, preferences, and cultural norms of the target population. Additionally, community-specific

nutritional counselling can serve as an enabler to ensure the optimal use of the food baskets, although further research is needed to evaluate the additive effect and cost-effectiveness of providing nutritional counselling alongside food support interventions.

Our results show that widespread coverage of a nutritional support intervention for patients with tuberculosis and their household contacts in India could prevent nearly 900 000 people developing tuberculosis disease (>2% of cases) and over 350 000 tuberculosis deaths (nearly 5%) by 2035. Such an intervention could have a substantial effect on the tuberculosis epidemic in India, reducing both incident tuberculosis disease and tuberculosis deaths, and is likely to be cost-effective at most willingness-to-pay thresholds. These results are likely to be a considerable underestimate, as considering the wider health benefits beyond tuberculosis would only further increase the benefit and cost-effectiveness of the intervention. There is an urgent need to generate further evidence, including implementation research to design intervention approaches and evaluate their implications, and from a wider variety of settings, to support rapid translation of this intervention into policy and practice.

Contributors

CFM, RAC, and RMGJH conceived and designed the study. CFM and PS did the tuberculosis data analysis. PA and RH did the food system modelling. RAC and RB did the tuberculosis modelling. CFM and RAC accessed and verified the data. CFM and RAC wrote the first draft of the manuscript. All authors critiqued the results, and revised and edited the submitted manuscript. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Equitable partnership declaration

The authors of this paper have submitted an equitable partnership declaration (appendix 4). This statement allows researchers to describe how their work engages with researchers, communities, and environments in the countries of study. This statement is part of *The Lancet Global Health*'s broader goal to decolonise global health.

See Online for appendix 4

Declaration of interests

AB is an unpaid member of the Scientific Advisory Committee, ICMR–National Institute of Nutrition, Hyderabad; and of the Strategic Technical Advisory Group on Tuberculosis, WHO South-East Asia Region and WHO, Geneva. All other authors declare no competing interests.

Data sharing

The analytic code and additional model results for this study are available online at https://doi.org/10.5281/zenodo.14160778.

Acknowledgments

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Annexure-2





Nutrition and Tuberculosis

May 26-29, 2025

2nd EDITION

Registration now closed!

COURSE FORMAT

Online only.
The course will be live to online participants approximately from 6:30 PM to 9:30 PM, IST (9:00 AM -12:00 PM Montreal, EDT time zone) each day.
Live content will be recorded
Content accessible to participants until July 1, 2025.

COURSE DIRECTOR

Anurag Bhargava, MD, MSc.
Professor, Department of Medicine,
Kasturba Medical College, Mangalore
Manipal Academy of Higher Education, Manipal
Adjunct Professor (Medicine), McGill University, Montreal

COURSE COORDINATOR

Madhavi Bhargava, MD
Professor,
Dept of Community Medicine,
Yenepoya Medical College

OBJECTIVES

By the end of the course, participants will:

- Understand nutritional requirements, causes, and consequences of undernutrition, including its effects on TB infection and disease.
- Learn about nutritional issues in TB patients, especially those with comorbidities like diabetes and HIV, and develop basic skills in nutritional assessment (history, anthropometry, clinical exam, dietary evaluation, biochemical assessment).
- Gain knowledge of nutritional counselling and management of undernutrition, including severe cases in TB care.
- Discuss recent research, guidelines, and the implementation of nutritional supplementation in TB care and prevention.
- Grasp cost-effectiveness analysis and modelling of nutritional interventions, and apply this knowledge to TB care and prevention programs.

OTHER COURSE FACULTY IN ALPHABETICAL ORDER

1) **Annabel Baddeley**: Technical Officer, Vulnerable populations, Communities and Comorbidities, Global TB Programme, WHO.
2) **Celso Khosa:** Instituto Nacional de Saúde (INS), Mozambique
3) **Chapal Mehra:** Survivors against TB, New Delhi, India
4) **Collins Timire:** Research Lead, National Tuberculosis Programme, Zimbabwe
5) **Dinis Nguenha**: Centro de Investigação em Saúde de Manhiça (CISM), Manhiça, Mozambique
6) **Edson Marambire**: The Health Research Unit, Zimbabwe, Biomedical Research and Training Institute, Harare, Zimbabwe
7) **Finn McQuaid:** Associate Professor, Dept of Infectious Disease Epidemiology and Dynamics, Faculty of Epidemiology and Population Health
8) **George PrayGod**: Chief Research Officer & Centre Manager, Muhimbili Medical Research Centre, National Institute for Medical Research, Tanzania
9) **Hemant D Shewade**: Scientist E, Division of Health Systems Research, ICMR National Institute of Epidemiology (ICMR-NIE), Chennai, India
10) **Hauwa Usman Garba**: State Technical Officer, KNCV, Nigeria
11) **Jeyashree Kathiresan**: Scientist E (Medical), ICMR- National Institute of Epidemiology, Chennai, India
12) **Jennifer Furin:** Harvard Medical School, Department of Global Health and Social Medicine, Boston
13) **Katharina Kranzer:** Department of Clinical Research, LSHTM, UK; The Health Research Unit, Biomedical Research and Training Institute, Harare, Zimbabwe
14) **Leyla Larsson:** Institute of Infectious Diseases and Tropical Medicine, Ludwig Maximilian University, Munich, Germany; Department of Clinical Research, LSHTM, UK; The Health Research Unit, Harare, Zimbabwe
15) **Pranay Sinha:** Assistant Professor, Section of Infectious Diseases, Boston University Chobanian and Avedisian School of Medicine
16) **Prosper Chopera:** Doctor of Public Health Nutrition | Project Lead Zvitambo Institute for Maternal and Child Health, University of Zimbabwe
17) **Scott Heysell:** Thomas H. Hunter Professor of International Medicine; Director, Center for Global health Equity, University of Virginia
18) **Soumya Swaminathan**: M. S. Swaminathan Research Foundation, Chennai
19) **Tom Wingfield**: Deputy Director of LSTN Centre for TB Research and LIV-TB Lead; Liverpool School of Tropical Medicine, UK

Nutrition and Tuberculosis | May 26-29, 2025: Register at:
https://www.mcgill.ca/summerinstitute-globalhealth/courses/institute-infectious-diseases-and-global-health/nutrition-and-tuberculosis

Session and Faculty		Topic/session	Time*
Day 1: May 26 (6:30 pm to 9:30 pm, IST (9.00 am to 12:00 am Montreal, EDT time zone)			
1.	Welcome and explanation of the course platform by McGill Co-ordinator, a quick round of introductions		6.30 – 6.45
2.	Anurag Bhargava	Introduction to the course and overview of TB and Nutrition	6.45 – 7.10
3.	Annabel Baddeley, WHO	WHO TB Nutrition Guidelines: What is new?	7.15 – 8.00
Break of 5-10 min			
4.	Pranay Sinha	ABCD of Nutrition Assessment in Patients with TB	8.10 – 8.45
5.	Madhavi Bhargava	Functional assessment and Nutritional Counseling	8.45 – 9.15
Wrap-up			
Day 2: May 27 (6:30 pm to 9:30 pm, IST (9.00 am to 12:00 am Montreal, EDT time zone)			
1.	George PrayGod	Evidence, recommendations, and gaps for energy-protein support in PwTB	6.30 – 7.15
2.	Anurag Bhargava	RATIONS trial, summary, and updates	7.15 – 8.00
Break of 5-10 min			
3.	Hemant Shewade	Learnings from implementing nutrition support for TB patients: The India experience	8.10 – 8.45
4.	Hauwa Usman Garba	Finding TB in malnourished children: A programmatic approach by KNCV Nigeria	8.45 – 9.15
Wrap-up			
Day 3: May 28 (6:30 pm to 9:30 pm, IST (9.00 am to 12:00 am Montreal, EDT time zone)			
1.	Scott Heysell	Drug therapy in severely undernourished patients with TB	6.30 – 7.15
2.	Anurag Bhargava	Micronutrients in PwTB: Vitamin A, Vitamin D, and anemia	7.15 – 8.00
Break of 5-10 min			
3.	Finn McQuaid	Modeling the effects of nutritional interventions in TB prevention and care	8.10 – 8.45
4.	Madhavi Bhargava	Qualitative findings from the RATIONS trial: Feasibility, acceptability, and other issues	8.45 – 9.15
Wrap-up			
Day 4: May 29 (6:30 pm to 9:30 pm, IST (9.00 am to 12:00 am Montreal, EDT time zone)			
1.	Pranay Sinha	Integration of Nutrition Assessment and Support in TB Care	6.30 – 7.15
2.	Panel Discussion	Session: Current evidence on undernutrition in PwTB and household members in Africa Panel: How do we respond to the TB-Undernutrition syndemic in Southern Africa Katharina Kranzer, Leyla Larsson, Dinis Nguenha, Celso Khosa, Collins Timire Edson Marambire	7.15 – 8.00
Break of 5-10 min			
3.	Panel Discussion	Nutrition-TB: Policy, practice, and research gaps: Soumya Swaminathan, Jennifer Furin, Chapal Mehra, Jeyashree Kathiresan, Tom Wingfield,	8.10 – 9.00
Wrap-up and Feedback			

*Each session time includes 10-15 minutes of discussion/Q&A



Nutrition and Tuberculosis

ONLINE ONLY | MAY 22-24, 2024

McGill



Course Director
Anurag Bhargava
Professor, Dept of Medicine, Yenepoya Medical College
Adjunct Faculty, Dept of Medicine
McGill University



Course Coordinator
Madhavi Bhargava
Associate Professor, Dept of Community Medicine, YMC
Deputy Head, Center for Nutrition Studies, YDU, Mangalore, India



Ashna Ashesh



Bharati Kulkarni



Finn McQuaid



Chelsie Cintron



Anura Kurpad



Renuka Jayatissa



Mario Raviglione



Soumya Swaminathan



Jeyashree Kathiresan



Millicent February

Registration: https://www.mcgill.ca/summerinstitute-globalhealth/

Course Format: Course will be live to online participants approximately 6:00pm to 9:00pm, Indian Standard Time zone (8:30-11:30am Montreal, EDT time zone) each day. Live content will be recorded and accessible to participants until July 1, 2024.

Target Audience: Students of Global Health, Medicine, Clinicians, Nurses, National TB program managers, TB researchers, nutrition professionals and researchers, TB Champions and advocates from civil society organizations, Health systems implementers and researchers

Course Objectives:

- **U**nderstand the elements of a person-centered approach to TB and nutrition
- Learn about nutritional requirements, anthropometric and clinical assessments including dietary assessment.
- Understand nutritional counseling and its application in the context of TB.
- Understand management of undernutrition including severe undernutrition in patients with TB, role of macro and micronutrients
- Discuss recent research on nutritional supplementation in TB care and prevention, and implementation of nutritional care in the field.
- Understand the role of epidemiological and economic modelling in estimating the population-level effects of nutritional interventions
- Apply this knowledge and skills to care and prevention of TB in their practice and programs.

Detailed technical program

Day and Time	Speaker	Topic/session (Each session of the 20 minutes, followed by a Q and A and discussion of 10 min)
Day 1: May 22		
6.30 – 6.50	Anurag Bhargava	Course overview: "TB and Nutrition: The big picture and historical Overview"
6.50 – 7.20	Ashna Ashesh, Survivors Against TB (SATB)	Community and public health policy perspective on TB and nutrition
7.20 – 7.55	Anura Kurpad	Nutritional requirements in patients with TB disease
Break: 5 minutes		
8.00 – 8.30	Madhavi Bhargava	Nutritional assessment: anthropometry and clinical
8.30 – 9.00	Renuka Jayatissa	Nutritional assessment: dietary and biochemical
9.00 – 9.30	Discussion and wrap up of the day	
Day 2: May 23		
6:30 – 7.00 pm	Anurag Bhargava	Implications of undernutrition in patients with TB: Status of management guidelines
7:00 – 7:30	Chelsie Cintron	Micronutrients and TB care and prevention: Current evidence
Break : 5 minutes		
7.35 – 8:05 pm	Bharati Kulkarni	Management of severe undernutrition in TB with learnings from management of SAM in children
8:05 – 8.35 pm	Madhavi Bhargava	Salient points for nutritional counselling of patients and families
8.35 – 9:30	Discussion, Q and A, regional perspectives from participants	
Day 3: May 24		
6:30 – 7:15	Anurag & Madhavi Bhargava	RATIONS trial overview & effects on patients and contacts and integration of nutrition in care and prevention
7:15 – 7:30 pm Session discussion – Q and A		
7:30 – 8.00	Finn McQuaid,	Modelling the effect of nutritional interventions on TB burden
8.00– 8.15	Session discussion and Q and A	
Break: 5 minutes		
8:20 – 9.00 pm	Panel discussion Moderator: Anurag	Brainstorming: Where do we go from here Mario Raviglione, Millicent February, Soumya Swaminathan, Jeyashree Kathiresan
9:00-9.30 pm: Final wrap up, discussion, feed back		

Enrolment: On popular demand we have increased the seats to 60 participants online. Last few seats available

Annexure-3

ICMR
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भारतीय आयुर्विज्ञान अनुसंधान परिषद
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Indian Council of Medical Research
Department of Health Research, Ministry of Health and Family Welfare, Government of India

File No. TB/04/2025/CD

Date: 28/03/2025

To,

Dr. Madhavi Bhargava
Professor,
Department of Community Medicine
Yenepoya Medical College
Yenepoya University Campus,
University Road, Deralakatte, Ullal, Karnataka 575018

Subject: Invitation for Consultation meeting: Strengthening TB-Nutrition Research in India on 7- 8th April 2025

Dear Madam,

On behalf of the Indian Council of Medical Research (ICMR), we are pleased to invite you to the Tuberculosis-Nutrition Workshop, organized by ICMR in collaboration with the Gates Foundation on April 7-8, 2025, at Conference hall, International guest house, National Institute of Health and Family Welfare, New Delhi, India.

The intersection of nutrition and tuberculosis presents a unique opportunity for scientific discovery and public health impact. This workshop will provide a scientifically rigorous and public health-relevant framework for integrating nutrition-based strategies into TB prevention and treatment efforts in India.

Given your expertise in this field, we believe your insights will play a pivotal role in shaping the discussions and outcomes of this event.

We cordially invite you to attend this important meeting.

For further information, please contact rp.debjani@gmail.com at your earliest convenience.

We look forward to your valuable contributions to what promises to be a highly productive and impactful summit.

Best regards,

Dr. Nivedita Gupta
Scientist G & Head
Division of Communicable Diseases
ICMR New Delhi

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ICMR INDIAN COUNCIL OF MEDICAL RESEARCH

Gates Foundation

Consultation meeting for strengthening TB-Nutrition research
(Organized by Indian Council of Medical Research in collaboration with the Gates Foundation)

Date: 7th and 8th April 2025
Venue: Conference hall, International guest House, NIHFW

Objectives of the workshop:

1. To review the available evidence on the role of nutritional interventions in aiding TB cure or reducing the incidence of TB.
2. To identify gaps in understanding the nutritional requirements and role of various nutritional supplements in improving outcomes of TB patients and prevent disease in high-risk contacts.
3. To identify the gaps in implementation of various existing schemes/ programs related to nutritional support with respect to TB patients.

Day 1 (Monday): 7th April, 2025		
Time	**Topic**	**Speaker/ panellist**
9-10:00 am	Registration	
10-10:45 am		
10 minutes	Welcome Address and objective setting for the workshop	Dr. Nivedita Gupta, Head, Division of Communicable Diseases, ICMR
10 minutes	Opening Remarks	Dr. Gagandeep Kang, Director-Enterics, Diagnostics, Genomics and Epidemiology, Gates Foundation
10 minutes	Overview of synthesis of evidence around nutrition intervention and Tuberculosis (Intervention-Findings-Areas of further research)	Dr. Banu Rekha (Sci-F, ICMR-NIRT)
15 minutes	Potential AYUSH nutritional supplements for TB patients	Dr. Rabinarayan Acharya, DG CCRAS
15 minutes	**Tea Break**	
11-12:15 pm	**Session I Moderator : Dr. Nivedita Gupta**	
15 minutes	" RATIONS Trial : Additional findings on acceptability, micronutrient status and body composition	Dr. Anurag and Dr. Madhavi Bhargava, Yenepoya Medical College
15 minutes	Tuberculosis—Learning the Impact of Nutrition (TB LION): an interventional	Dr. Pranay Sinha, University of Boston

	study to decrease TB risk in household contacts	
15 minutes	Impact of Under nutrition on Tuberculosis Treatment Outcomes in India: A Multi-center, Prospective, Cohort Analysis	Dr. Sonali Sarkar, Jawaharlal Institute of Postgraduate Medical Education & Research
30 minutes	Q & A and Discussion	
12:15 - 1:15 pm	**Session II Moderator : Dr. Gagandeep Kang**	
15 minutes	Overview of India's approach in developing NIN-RDA recommendation for general population → Context setting for the need for supplementation for repletion in high-risk population such as TB patients and contacts	Dr. Bharati Kulkarni, Director, ICMR-NIN
15 minutes	Modelling impact of nutrition on TB (Review of various models and their implications)	Stewart Chang, Institute for Disease Modelling (Recorded Session)
15 minutes	Q & A and Discussion	
15 minutes	Programmatic Priorities in research related to Nutrition in Tuberculosis	Dr. Urvashi Singh, DDG TB , Central TB Division
1:15-2:00 pm	**Lunch break**	
2:00-3:00 pm	**Session III Moderator : Dr. Bharati Kulkarni**	
15 minutes	Downes / Papworth intervention studies: Implications for future research	Dr. Chris Karp, Director Translational Sciences, Gates Foundation
15 minutes	Hypothesis on micronutrients in TB/ recent study designs and protocols for deployment in Africa, Indonesia and other countries	Tor Strand, Professor, Center for International Health
15 minutes	Learnings from implementing nutrition support for people notified with TB: India experience	Dr. Hemant Deepak Shewade, ICMR- NIE
15 minutes	Q & A and Discussion	
3:00 - 4:40 pm	**Session III – Group work on identification of priority clinical research questions**	
10 minutes	**Orientation : Dr. Leyanna Sussane George**	
60 minutes	**Group Discussion to generate key research questions** **Three working groups:** **Group 1: Nutritional requirements WG** *(Eg: Basic research on identifying macro/micro nutrient requirements & tools for measurement of impact of nutrition for different groups like children/ pregnant/*	

	lactating women with TB, DS/DR TB, Co-infections with HIV/TB etc) **Group 2: Nutrition supplementation WG** *(Eg: Clinical trials with different combinations of AYUSH products, culturally acceptable food, macro/micro nutrient supplements/EDNS etc)* **Group 3: Innovations and Implementation research in Nutrition WG** ***(Innovation:** Eg: Validation of newer tools such as nutritional counselling techniques, nutrition booklets, nutritional adherence tools, use of geo mapping for delivery of nutrition kits, AI powered digital health tool for anthropometry etc* ***Implementation**: Eg: Implementation research on mechanisms for delivery of nutrition to different populations, Food Baskets, DBT, Nikshay Mitra, Nikshay Poshan Yojana nutritional rehabilitation centres et,c*	
30 minutes	Q&A, Wrap-up of Day 1 and Context setting for synopsis development on Day 2	Dr. Nivedita Gupta
Tea Break		
End of day 1		
Day 2 (Tuesday): April 8, 2025		
10-1:15 pm	**Session IV - Working Session – Development of a synopsis for the key research questions identified on Day 1**	
60 minutes	Continuation of Group Work	
90 minutes	Presentation of group work	Moderated by: Dr. Bharati Kulkarni Dr. Nivedita Gupta Dr. Gagandeep Kang
30 minutes	Summation & Next Steps	Dr. Nivedita Gupta
15 minutes	Vote of Thanks	Dr. Debjani
1:15 pm	**Lunch Break**	
End of day 2		