ORIGINAL RESEARCH ARTICLE

Longitudinal Study on Dynamics and Determinants of Nutritional Status among Children Suffering from Tuberculosis in Purulia District of West Bengal

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ABSTRACT

Introduction: Malnutrition in children is a significant cause and risk factor for tuberculosis infection and mortality. This study tracked changes in nutritional parameters among tuberculous children in a public health context.

Methodology: This longitudinal field-based study was conducted among assenting below 18 tuberculous children in Purulia, West Bengal Monthly anthropometric measurements were taken by trained healthcare workers, and biochemical parameters were recorded at baseline and the end. A weekly food diary was maintained for 24 weeks. Data was analyzed using R 4.4.1 and World Health Organization (WHO) Anthro software.

Results: Of 32 recruited children, 2 died and 5 were excluded from the analysis, sample size at end of analysis was 17 with 50.0% having extra pulmonary tuberculosis. Four children were under 5 years of age. Analysis as per standardized Z score showed persistent malnutrition (<-1Z-score) for BMI for age and <-2Z for height-for-age, while weight-for-age improved from -0.04 Z to -0.02 Z. Statistically significant changes in hemoglobin levels in girls (p=0.007) were noted. The food diary indicated that children missed an average of one meal per day, particularly protein and green vegetables.

Conclusion: Targeted nutritional interventions for children and support beyond treatment completion are necessary.

Keyword: Childhood Tuberculosis, Malnutrition, World Health Organization growth parameters

ARTICLE INFO

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INTRODUCTION

Tuberculosis, a known killer disease, has been targeted for elimination by 2025.According to World Health Organization_people with active TB disease have an elevated basal metabolic rate and, consequently and a higher caloric turnover.[1] During critical periods of childhood and adolescence, growth & development should be at par with a healthy child so that once cured, disease should not leave lasting scars on their future potential. Hindrance to this end is multifactorial, while tuberculosis itself causes debilitation, poor nutrition again is an independent factor for stunting and underweight states. Studies in Ethiopia by Wagnew F et al[2] and DeAtley T et al[3] in South Africa both emphasize that childhood malnutrition was linked with TB and nutritional support can improve successful TB outcomes. Ko Y et al[4] in Seoul depicted that compared to smear positive group smear negative group had lower BMI. Children had higher risk of death or treatment failure in case they are underweight as shown by Chiang SS et al.[5] Sinha P & Hockberg NS noted that every unit increase in BMI decreased the death risk during treatment of tuberculosis.[6] It can be rightly concluded that nutrition is both a cause and consequence of tuberculosis as was opined by Sinha P and Davis J.[7] Not only from the viewpoint of a positive association, pharmacokinetics and pharmacodynamics of antituberculosis drugs in children with severe malnutrition may be significantly different compared to nourished children, and understanding these differences is essential for optimizing treatment of TB in children with malnutrition.[8] Husain B et al in Ethiopia suggests that nutritional support is required for TB treatment.[9] The Government of India provides a monetary benefit for TB patients which in case of children reaches their parents with uncertain appropriation of funds for nutrition. Furthermore, food habits, practices age-wise and region-wise also need to be explored irrespective of uniform monetary benefits to all patients. A population nutritional profile for determinants of Tb incidence as suggested by Cigielski JP et al is necessary.[10]

This study was done assessing the growth parameter changes from a population viewpoint using WHO growth reference for population studies among children with tuberculous in Purulia district of West Bengal. Purulia district shows poor nutritional parameters in National Family Health Survey 5[11] among children and, with 46.3% of children underweight, 36.9% stunted and 29.4% wasted. District shows lower Human Development index[11] justifying the study in this district. Study designed for investigating nutritional changes among such population can be reflective of best preventive procedures to be adopted if necessary to address the population with low nutritional reserve. Pre-existing malnutrition burdened with Tb and its outcome was studied among children in this district. This longitudinal study was conducted at a community field level extending over all 20 blocks throughout the district recruiting for 10 months with each case followed up for 6 months.

METHODOLOGY

Study design: Study was conducted in the entire district of Puruliya from July 2022 to March 2024. Ethical clearance was obtained from Institutional Ethics committee from Deben Mahato government Medical College and Hospital bearing no IEC/DMGMCH/2021 /09, dated 14/06/2021. Following ethical clearance and administrative approval, subjects were recruited over a period of 10 months. Longitudinal, community based, study was conducted among children, with consent from parents or legally responsible person in the district of Purulia.

Total enumeration of all cases under 18 years of age registered under NTEP portal from August 2022 to July 2023 in the district of Puruliya. Those who had a permanent address indicating mother residing in the district for a period of at least 6 months were included Finally consenting legal guardians were included.

Following consent, the local HCW (health care worker) was trained to accurately collect data on anthropometric parameters and periodically fill up the data collection format. Baseline assessment done within the first 2 weeks of registration of the subject in NTEP. Blood test was done at start of study and upon completion of 6 months of treatment irrespective of status of treatment outcome. Each subject was followed up for 6 months monthly. Food diary for a once-a-week assessment for 24 weeks of each subject was done describing the number of missed meals and missed food groups by trained HCW Height and weight was measured on a metric scale suitable to be used in Anthro software. developed by World Health Organization (WHO) for free public usage.

Sample size: The study was planned as enumeration of all children aged between 0-18 years, who were diagnosed with tuberculosis. Information showed that 36 cases were registered within the time frame, and 32 were eligible and of them provided consent/assent to join the study. For every child, 14 anthropometric measures and 24 food diary readings were expected over a period of 6 months. Loss was encountered at various points. Subjects who were lost within 4 weeks of recruitment were excluded from final analysis. Subjects whose data available for 75% period of follow-up were included in analysis of anthropometric parameters. Eventually the sample size was 32. Of which 2 deceased not included in analysis, 2 was lost to follow up within 4 weeks and 3 had data available of less than 75%hence excluded from analysis.

Completed data for BMI (both height and weight) were available for 17 subjects, analyzed for BMI at baseline with number reduced to 14 at end of 6-month follow-up.

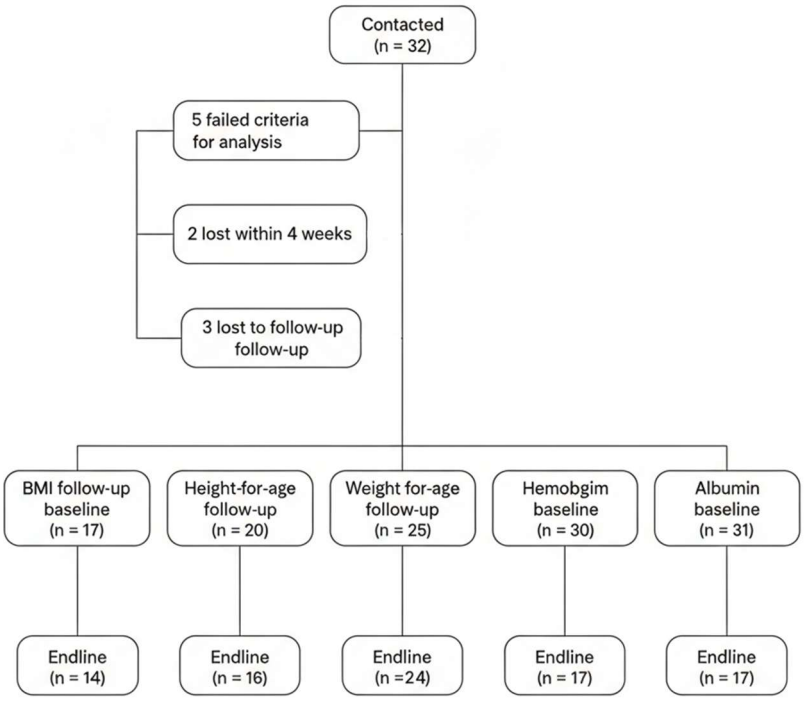

Figure 1: Showing study subject follow-up over a period of 6 months as per each growth parameter

For height for age data was available for 20 subjects for baseline with reduction to 16 at end of follow-up. 25 subjects were analyzed for weight for age at baseline with complete data available for 24 at the end of 6 months.

RESULTS

Anthropometric assessment. using WHO growth reference boys and girls (WFA.HFA, BMI for age were used. Biochemical assessment included hemoglobin percentages, and albumin at baseline and end line.

Table 1 shows the age and gender wise distribution of the enrolled subjects. There were 15 girls and 17 boys. Of the total 4 were under 5 years of age. The age range of patients varied from 8 months to 18 years 50% of subjects had extrapulmonary tuberculosis. With one case being MDR Tb.

Table 2 shows the hemoglobin and albumin estimation at baseline and endline along in boys and girls. Blood parameters were available from n =30 at start and n=17 at end showed subjects mean hemoglobin 10.6 (SD 1.5) and 11.5 at end (SD 1.3) with significant change with a paired t test (p=0.004) Albumin for sample 30 at start and 16 at end had mean of 3.9(SD 0.8) at baseline changing 4.3 (SD0.3) with no significant change. Sex wise analysis showed significant change in Hb level between pre and post treatment in girlsp-0.007, mean hemoglobin being 10.1(SD1.5) and 10.4(SD0.5) (paired t test was used) No other change was observed to be significant.

Based on data availability at each stage the sample for each Fig 2&3 has been mentioned separately. Information on missed meals and food groups were noted from the food diary.

Table 1: Clinical profile of study population (n=32)

Age	Boys	Girls	Extrapulmonary	Detected Clinically Only	Detected Microbiologically	Detected As MDR
Under 5	3 (17.6%)	1 (6.7%)	1 (6.3%)	1 (7.1%)	3 (16.7%)	0 (0%)
Under 9	2 (11.8%)	3 (20%)	0 (0%)	0 (0%)	5 (27.8%)	0 (0%)
Adolescent	12 (70.6%)	11 (73.3%)	15 (93.8%)	13 (92.9%)	10 (55.6%)	1 (100%)
Total	17 (100%)	15 (100%)	16 (100%)	14 (100%)	18 (100%)	1 (100%)

Table 2: Biochemical parameters change

Subject	Parameter	Baseline	Endline	Inference (p value)
All subject n=31	Albumin	3.9 ± 0.8	4.3 ± 0.3	0.13
All subject n=30	Hemoglobin	10.6 ± 1.5	11.3 ± 1.3.	0.004*
Boys	Albumin	4.2 ± 0.3.	4.5 ± 0.2.	0.16
	Hemoglobin	9.9 ± 3.9.	12 ± 1.3.	0.50
Girls	Albumin	3.6 ± 1.1	4.1 ± 0.2.	0.143
	Hemoglobin	10.1 ± 1.5.	10.4 ± 0.5.	0.007*

Paired t test done for each pair

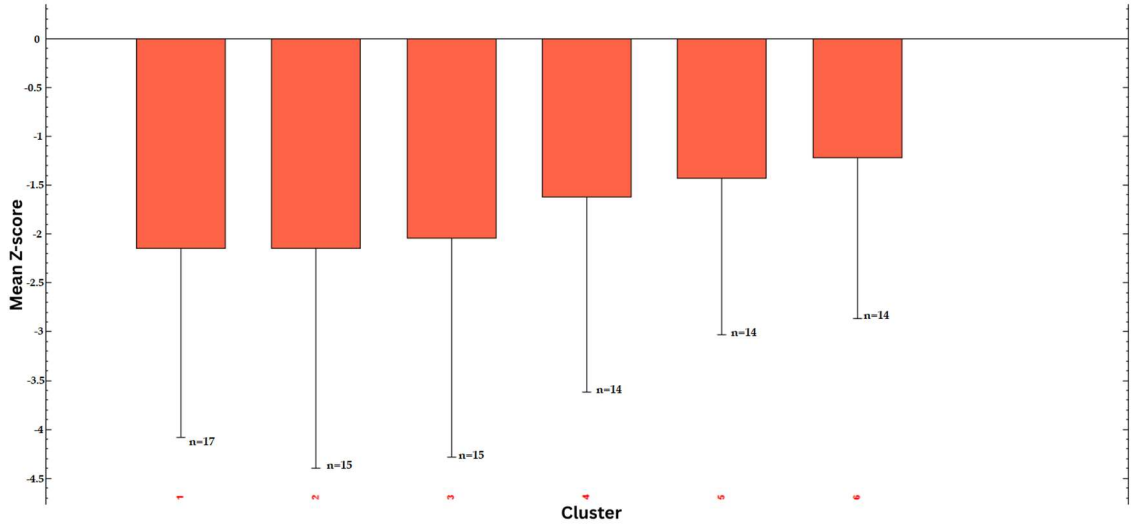

Figure 2a: BMI for age over 6 months (cluster denotes month of treatment). Negative Z score or persistent sequelae of chronic malnutrition n=17 at start with n=14 at end

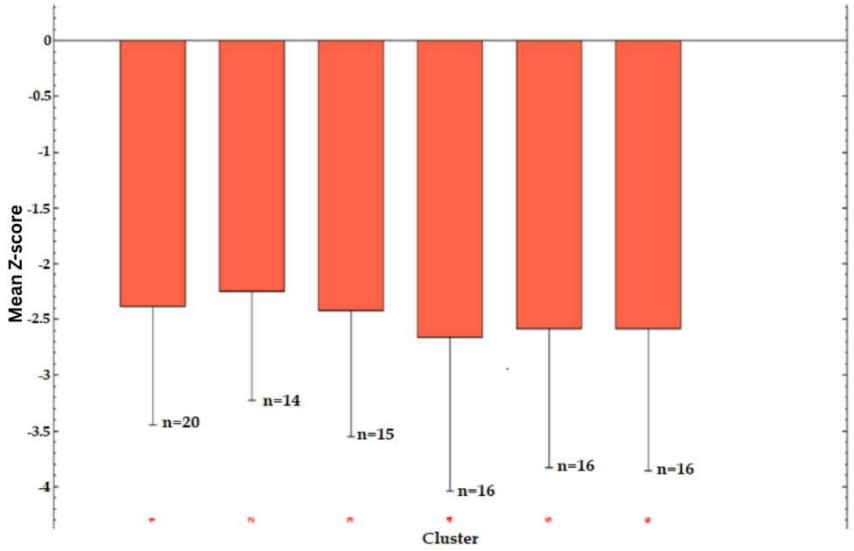

Figure 2b: Height for age over 6 months (cluster denotes month of treatment). Negative Z score or persistent sequelae of chronic malnutrition n=20 at baseline and 16 at end

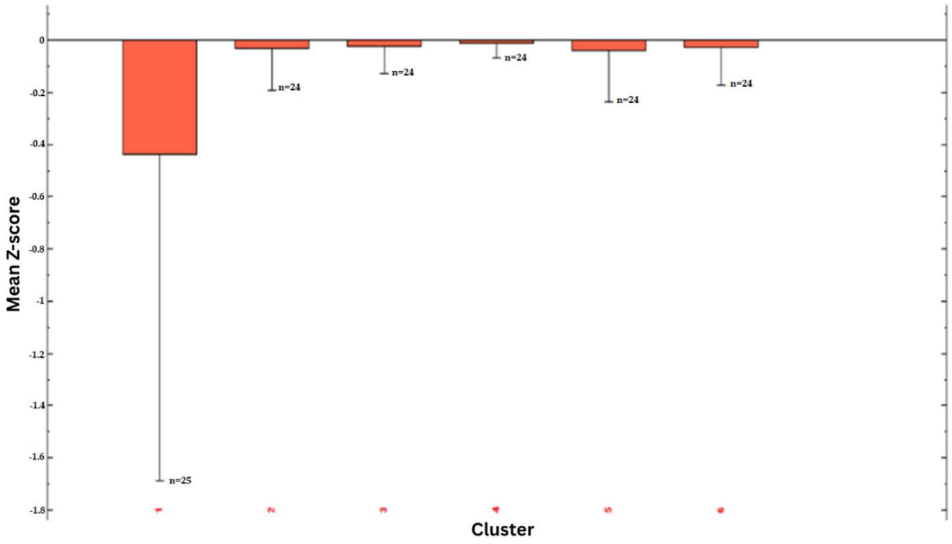

Figure 2c: Weight For Age Over 6 Months (Cluster Denoted Month of Treatment) Negative Z Score Changes to Positive Z Score Indicating Improvement of Nutrition Status N=25 At Baseline And 24 At E

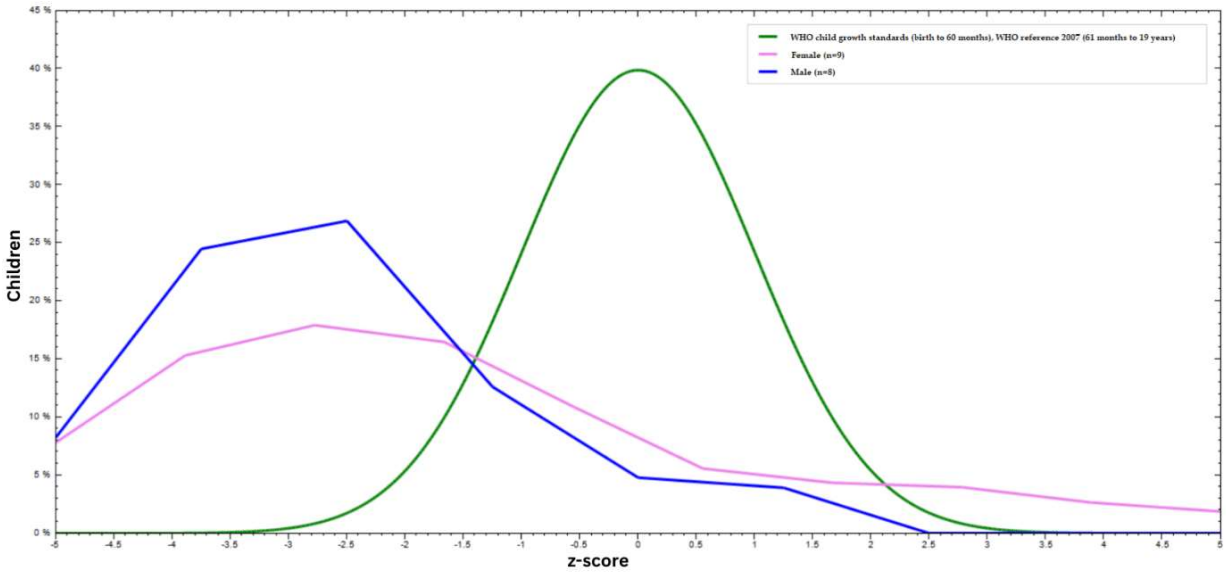

Figure 3a: n= 17 BMI for age showing malnutrition at baseline in both sexes. (Green indicates expected normal pattern of BMI distribution in population while pink and Blue indicate pattern observed in girls and boys. Curve indicates baseline nutritional status to be less than desired population parameter extending to less than -2z n=17

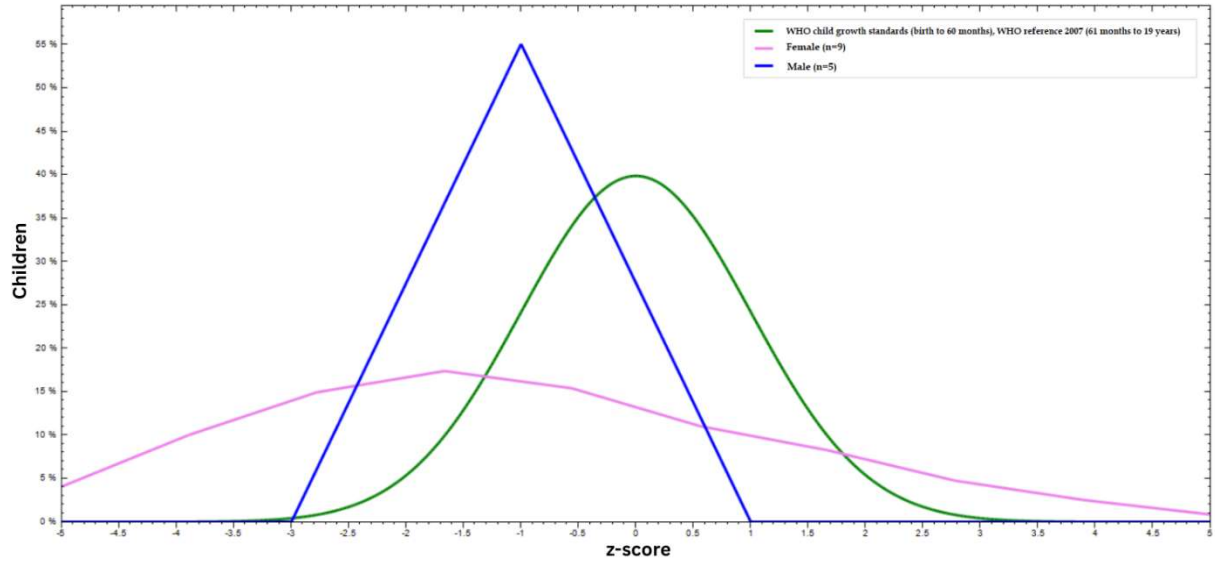

Figure 3b: n=14 BMI for age indicating malnutrition at end line in both sexes BMI changes for boys to be better than girls at end of 6 months with lower limit at -3z n=14

The anthropometric parameters for age were interpreted to a standardized age-appropriate Z score using WHO Anthro and Anthro-Plus software. Change in three measures over 6-month follow-up was analyzed.

Fig-2a shows BMI for Age (baseline n= 17 and end line 14)s BMI to change from -2Z to -1z i.e. persistent undernutrition. Most fall was observed in the first month

Fig-2b shows height change over 6 months with (n=20 at baseline and endline n=16). Persistent malnutrition was seen with baseline and end line reading near -2z

Fig-2cs shows weight for age change over 6 months with (n=25 at baseline and 24 at end) of 6 months Weight was a more sensitive indicator showing a change in nutritional status from -0.04z to -0.2z at end of 6 months

Fig 3a and 3b show persistent malnutrition in both sexes (blue for boys and pink for girls) at start and end of 6 months with leftward shift of curve continuing with baseline n=17 and endline 14.

Figure 4 indicates the number of meals consumed by children in a single day recorded over the study period. Over the 24 weeks of follow-up, information on food intake was collected every week. For each child, throughout the follow-up, the proportion of weeks in which a child consumed 4 meals and 8 food groups were calculated.

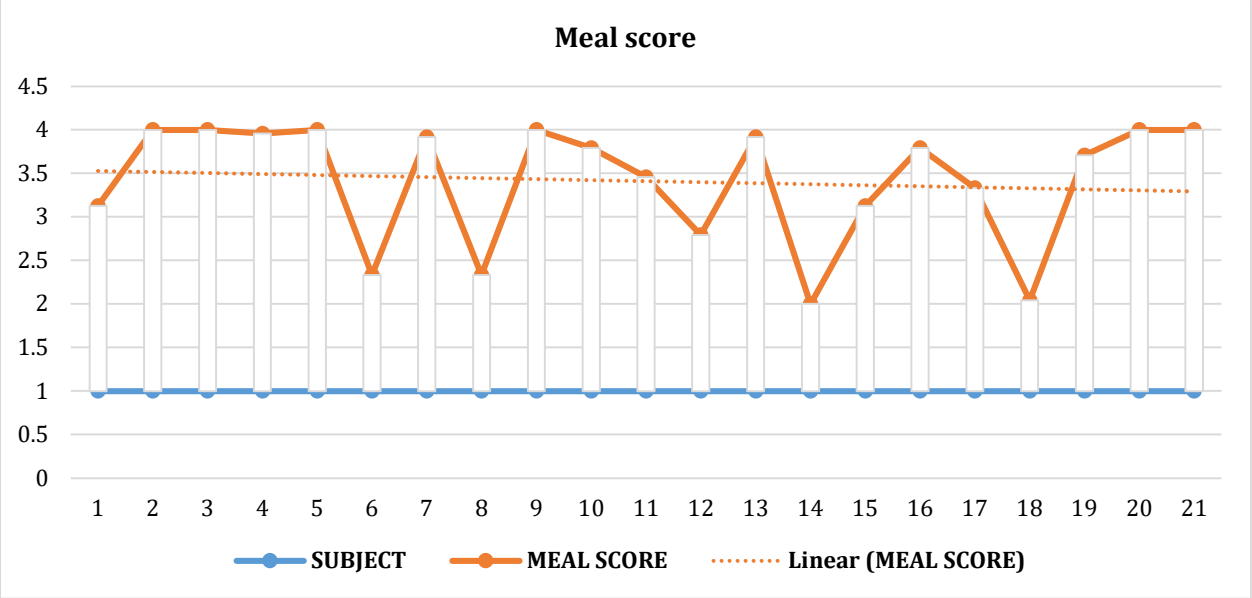

Figure 4: Subject wise number of meals consumed. Count of 24 full weeks were available for 21 subjects depicted in graph (subjects under 2 years of age were excluded from this analysis)

On average in 77.0% of weeks, subjects reported consumption of 4 meals/day, breakfast was the meal which was mostly skipped. In only 16.0% of weeks, subjects reported consumption of 8 food groups. Protein of animal origin followed by green leafy vegetables were the commonly missed ones. However, on individual analysis it was seen that there were some subjects who never had 4 meals a day or never consumed all 8 food groups, in any of these 24 weeks.

Discussion

The study aimed to capture the change in nutritional parameters, among children and adolescents undergoing treatment for tuberculosis and identify necessity of policy wise introduction of food supplements to tuberculous children.

Of the 32 recruited 16 subjects were followed up till end with all data available. 50.0% were females; and 50.0% cases were extra pulmonary in nature. A hospital-based study in Pune by Jain SK et al showed extra pulmonary cases to be 46.0%, and girls accounted for 46.0% cases with 57.0%, patients were malnourished at the time of start of treatment.[12] The similarity in two studies may be indicative of a common pattern. This study indicates (based on WHO reference, nutritional parameters) persistent malnutrition. among tuberculous children even at end of treatment.

On exploring the parameter change from a population viewpoint using WHO growth parameter for population entire cohort shows persistent malnutrition states in parameters of BMI, which failed to reach normal cutoff points. Burusie A from Ethiopia stated that such persistent malnutrition under 10 years of age increased the mortality risk in the tuberculosis patients.[13] Franke MA also found persistent malnourishment where the average BMI value of adults increased during treatment, but still they failed to attain the cut-off of normal BMI.[14] Chronic malnutrition leaves a permanent scar in the form of stunting. However, positive weight change indicates scope for improvement with continual nutritional support. The disproportion of change in WFA and HFA may be addressed with nutritional support for extended period beyond the treatment phase for a period till catch up growth can be achieved protecting the vulnerable population against reinfection.

With stunting being a sequel of chronic malnutrition the parameters of BMI for age and height for age may not be the best growth parameters to monitor improvement of nutritional status in cases of childhood tuberculosis. With preexisting malnutrition, weight for age may be a better parameter for monitoring in such cases which is reflected in the present study. Cho SH et al findings suggest a significant inverse relationship between BMI and TB incidence, which was especially profound in the underweight population.[15] Airlangga also points out body weight to be an important sign in children with tuberculosis.[16] Public health strategies to screen TB more actively in the underweight population and improve their weight status may help reduce the burden of TB.

Biochemical assay for nutrition reflected statistically significant change in hemoglobin levels level in girls. A low albumin level increases the risk of tuberculosis infection while multivitamin supplementation causing a rise in hemoglobin of blood was observed by Huynh J et al[17]. Nutritional profiling, multivitamin supplementation can be avenues to explore to improve treatment outcome and long-term nutritional status of tuberculous subjects. Sinha P et al[18] also emphasized the importance of integration of nutritional assessment into standard Tb care plan.

The food diary maintained over 24 weeks shows an average of one missed meal per day. Mostly breakfast and also 2 food groups, notably green leafy vegetables and animal protein. Sumatra Airlangga points out the drawback of being unable to find an in-depth assessment of food intake before and during tuberculosis treatment, which the present study captured to an extent.[16] Similar low dietary score was observed by Hao JQ in North China[19]. Bacelo AC in Brazil suggests that loss of appetite coupled with gastrointestinal problems were cause of poor eating[20]; Ayirayeetil R indicating high level food insecurity to cause poor eating[21].

This study did not investigate the cause of adverse food habits, but a recently in 2023-2024concluded RATIONS study in Jharkhand, India has successfully depicted 48.0% reduction in tuberculosis incidence in household contacts by nutritional supplementations with weight gain in tuberculous patients, particularly in the first 2 months, being associated with a substantially decreased hazard of tuberculosis mortality[22]. Echoing such findings are suggestions by Jagannath D et al[23] in his review in India and Frank MA et al[14] working in the SubSaharan region who states urgent need to revise nutritional support particularly for children under 5 with Tb.

The chief findings of the study show persistent malnutrition in tuberculous children at end of six months. Adjusting with data reflective of previous chronic malnutrition namely stunting or any height dependent parameter, persistent malnutrition status persists even at end of 6 months This leaves the child vulnerable to reinfection as also losing an opportunity to address chronic sub nutrition and place the child on road to health.

The National Tuberculosis Elimination Program presently offers monetary support, of 1000 INR monthly which are liable to misappropriation with diversion from strict dietary support. The RATIONS[22] study among adult tuberculous patients where raw food supplementation was given caused weight gain, which was associated with a substantially decreased hazard of tuberculosis mortality.

The present study depicts food consumption to be below required standards vis food diary with failure to consume protein regularly. This period in the child growth cycle requires adequate protein among other nutrients for optimum growth, which in catabolic state like tuberculosis is increased. Chronic malnutrition state added with tuberculosis creates a protein calorie deficit.

While monetary incentives are useful to tuberculous subjects of all age group an extra supply of raw food material for those whose protein requirement per day is more than average adult requirement may be useful. In keeping with available data from RATIONS Study supply of raw food/cooked food for a period of 6 months and beyond to ensure catch up growth and prevention of reinfection should be useful. Providing nutritional support to tuberculous subjects has been taken under the Government of India scheme Nikshay Mitra. Also, it is known that under Integrated Child development scheme every child receives supplementary nutrition in form of a meal. This channel may be to provide extra calorific addition to tuberculous children beyond treatment period to ensure catch up growth may be instituted. Considering the success of RATIONS study such nutritional support to tuberculous children using an existing platform can definitely improve the nutritional status preventing long term sequelae.

Limiting aspects of this study was the small sample size possibly less detection with loss to follow-up. Also, this study also did not investigate the factor of intestinal parasites which affect nutritional status adversely as suggested by Cintron C et al[24] and Fesiya JW et al[25]. More research avenues include scope of dietary improvement via public channels, in depth analysis of socio-economic norms affecting food intake, effect of prolonged dietary support to ensure growth pattern reaches optimum healthy level for long term benefit. Age wise food supplementation amount also needs to be studied in detail before prescribing policy wise raw food supply to subjects under 18 with tuberculosis. A multi-state wider study with nutritional supplementation can help devise nationwide strategy.

CONCLUSION

Acknowledging the existing service provision integrating nutritional assessment into standard care is crucial. Integration of nutritional assessment in standard care, nutritional benefits specially targeted for children, support beyond treatment completion are points to be looked into to target better treatment outcome and Tb elimination. Evidence based study suggests nutritional assessments including need for supplementary and therapeutic nutrition should be done for every child and can be provisioned through Nutritional Rehabilitation Centers, ICDS scheme or otherwise as per individual requirements.

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Availability of Data: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Declaration of Non-use of Generative AI Tools: This article was prepared without the use of generative AI tools for content creation, analysis, or data generation. All findings and interpretations are based solely on the authors' independent work and expertise.

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