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# Role of nutritional supplementation in patients with newly diagnosed pulmonary tuberculosis

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**Abstract**
Malnutrition is common among tuberculosis patients and is associated with mortality. Nutritional support is often recommended as part of the treatment. The objective of the study was to assess the effect of supplementation of nutrient rich diet (formulated diet) on microbiological and radiological recovery in patients with pulmonary tuberculosis. Freshly detected tuberculosis patients (120) aged between 25-55 years matched for age and sex who have no past history of tuberculosis were selected for the study. The experimental group (n=60) received 100gms of ready to eat food supplement in addition to daily food intakes. The second group (n=60) was taken as control group. Both groups received the same anti-tuberculosis treatment recommended by World Health Organization. Clinical examinations and anthropometric measurements were carried out before and after the experimentation. A significant difference was not observed in body weight after the intervention between the control and experimental groups. Regarding body mass index a significant difference was observed after intervention. ($p \leq 0.05$). The mean increase in body weight and body mass index was 4.75 kg and 2.02 kg/m$^2$ in the experimental group after 2 months of supplementation. Sputum conversion and resolution of X-ray lesion area occurred earlier in the experimental group. Thus a nutrient rich diet improves the effect of tuberculosis medication and results in earlier sputum smear conversion.

**Keywords:** tuberculosis, nutrient supplementation, sputum smear conversion, x-ray lesion area

## Introduction
Tuberculosis (TB) is one of the world's deadliest diseases. One third of the world's population is infected with TB. For the past 5 years, it has been the leading cause of death from a single infectious agent, ranking above HIV/AIDS. India accounts for one fourth of the global TB burden (TB India, 2017) [16]. Tuberculosis mainly affects young adults who are in the economically productive years of their lives (15-54 years) thereby causing huge social and economic disruption. This, in turn, hampers the development of the country (TB India, 2005) [15]. Tuberculosis and malnutrition are interlinked. They go hand in hand. Even though tuberculosis is not a nutritional disorder, tuberculosis causes malnutrition and malnutrition is important in the genesis and in the etiology of tuberculosis. Several studies reported that patients with active pulmonary tuberculosis are malnourished as indicated by reduction in visceral proteins, anthropometric indexes and micronutrient status (Onwubalili, 1988) [11].
Protein energy malnutrition adversely affects the host immune response to Mycobacterial infection. Hence, there is a need for high calorie, high protein diets which are often neglected in prescribing to tuberculosis patients. Therefore food based on high calorie and high protein was formulated to meet the requirements of tuberculosis patients and to see the treatment outcome. It was used as supplement in addition to the daily diets. Nutritional counseling was given to make the tuberculosis patients aware of the need for high calorie, high protein diets.

## Materials and Methods
### Supplementation of Ready to eat Food Mixture for Tuberculosis patients
A ready to eat food mixture that was prepared and found to be highly accepted using Ragi(Eleusinecoracana), Soyabeans (Glycine max), Peanuts(Arachis hypogea) and Black gram (Phaseolusmungo) (Anuradha,2017) [2] was supplemented to newly detected tuberculosis subjects. The product had a fat content of 8.37 g and protein content of 19.86 g.

### Experimental Design
The feeding trial was designed as a two months study. One hundred and twenty freshly detected Tuberculosis subjects aged between 25 – 55 years matched for age and sex who have no past history of Tuberculosis and who have no other complications like diabetes, HIV, pregnancy or currently breast feeding etc. were purposefully selected based on X – ray of the chest and smear examination of the sputum for the presence of acid fast bacilli. The sample design is given in fig.1. The initial heights and weights were recorded to calculate the Body Mass Index (BMI). Then the one hundred and twenty TB subjects were divided into experimental (60) and control (60) groups. Both groups received the same anti tuberculosis treatment recommended by the World Health Organization. The experimental group was given 100g of the ready – to – eat food supplement with the addition of 100g jaggery so that it could meet 1/3$^{rd}$ of the day's requirement for proteins and calories. They were asked to consume the

supplement in addition to their daily food intakes. Both the groups were counseled on the need for high calorie high protein diets.

The general health of the subjects was monitored for the first few days. All the 60 subjects were fed till 2 months. After intervention Body Weight and Body Mass Index (BMI) were recorded. To know the sputum smear conversion, sputum was tested for acid fast bacilli weekly until the sputum smears turned negative and also at the end of the experiment. X – ray of the chest was done monthly once till two months.

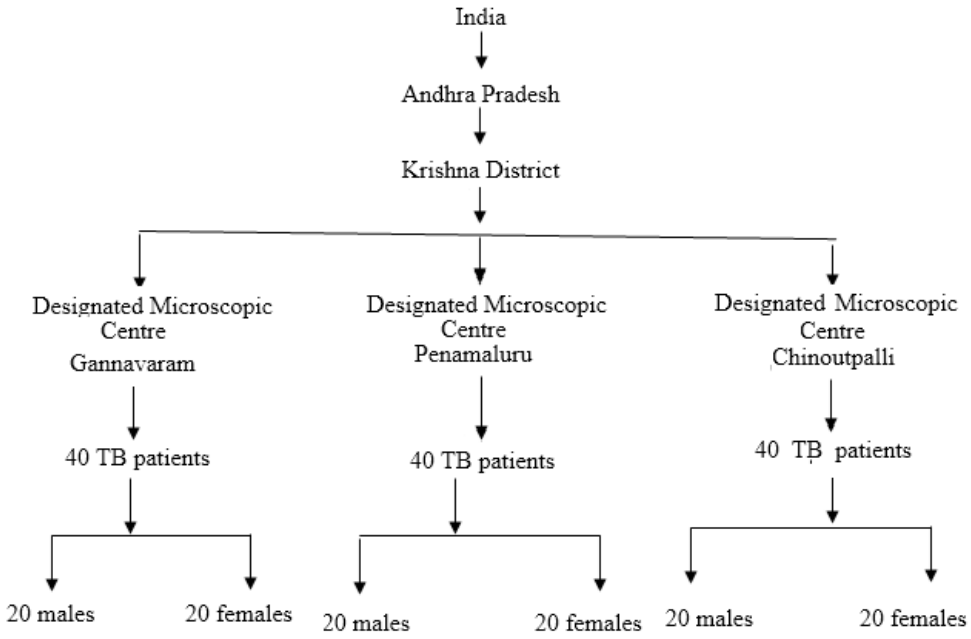



**Fig 1:** Sample Design

**Measurement of Body Weight and Body Mass Index (BMI)**

The BMI was calculated as Weight in (kg) / Height in $(m)^2$

BMI is used to determine the Chronic Energy Deficiency (CED) in the subjects. CED has been defined as a steady state at which a person is in energy balance, although at a cost either in terms of risk to health or an impairment of function and health. The BMI values between 18.5 and 24.9 were considered compatible with health for both men and women while the values below 18.5 were classified as CED. The degree of malnutrition in the subjects is assessed as < 18.5 – malnutrition, 17 – 18.4 – mild malnutrition,16 – 16.9 – moderate malnutrition,< 15.9 – severe malnutrition (NIN, 1991) [9].

**Sputum Examination**

Sputum examination was done using standard procedure. (TB India, 2005) [15].

**X-ray of the chest**

To see the radiological recovery, X-ray of the chest was done monthly once till two months.

**Statistical Analysis**

The data obtained was analysed using Means, Standard deviations, Independent sample student's t-test and Paired t-test.

**Results and Discussion**

**Effect of Nutritional Supplementation on Body Weight and Body Mass Index**

Wasting is generally present in tuberculosis patients. Wasting causes loss of fat and lean tissue. In order to restore the wasting tissue, supplementation of protein rich food mixture was advised, and the effect of supplementation was measured before and after the intervention and is presented in Table No.1&2.

**Table 1:** Effect of Nutritional Supplementation on Body Weight and Body Mass Index in the control and experimental groups

| Parameter | Group | Status | Mean | S.D | t-value | p-value | Remark |
|---|---|---|---|---|---|---|---|
| Body weight (kg) | Control | Initial | 41.67 | ±5.83 | | | |
| | | Final | 43.16 | ±5.41 | -19.78 | 0.000 | Sig@1% level |
| | Experimental | Initial | 40.10 | ±7.49 | | | |
| | | Final | 44.85 | ±7.88 | -37.61 | 0.000 | Sig@1% level |
| Body mass index (kg/m2) | Control | Initial | 16.50 | ±0.76 | | | |
| | | Final | 17.10 | ±0.71 | -13.91 | 0.000 | Sig@1% level |
| | Experimental | Initial | 16.52 | ±1.92 | | | |
| | | Final | 18.54 | ±1.97 | -26.313 | 0.000 | Sig@1% level |

**Table 2:** Comparison of mean Body Weight and Body Mass Index between control and experimental groups

| Parameter | Status | Group | Mean | S. D | t-value | p-value | Remark |
|---|---|---|---|---|---|---|---|
| Body weight | Initial | Experiment | 40.10 | ±7.49 | -0.904 | 0.370 | NS |
| | | Control | 41.67 | ±5.83 | | | |
| | Final | Experiment | 44.85 | ±7.88 | 0.964 | 0.339 | NS |
| | | Control | 43.16 | ±5.41 | | | |
| Body mass index | Initial | Experiment | 16.52 | ±1.92 | 0.042 | 0.966 | NS |
| | | Control | 16.50 | ±0.76 | | | |
| | Final | Experiment | 18.54 | ±1.97 | 3.746 | 0.000 | Sig @ 1% Level |

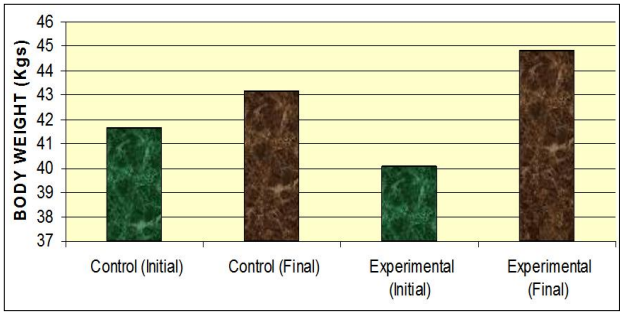



**Fig 2:** Effect of Nutritional Supplementation on Body Weight

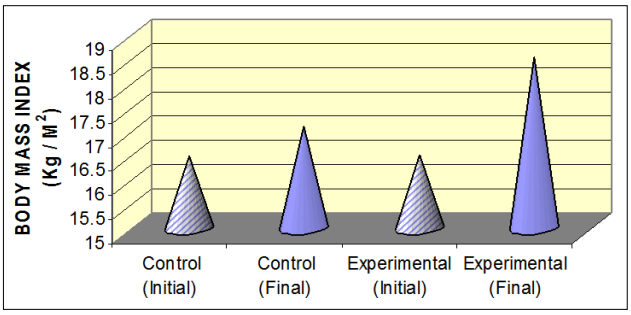



**Fig 3:** Effect of Nutritional Supplementation on Body Mass Index

The impact of nutritional supplementation on body weight and body mass index is shown in Table No.1and 2 and figures 2 and 3. When paired t-test was done a significant difference ($p < 0.05$) was observed in body weight and body mass index in both control and experimental groups indicating that tuberculosis patients who participated in the study were able to gain weight during the period of two months experimentation. Even though significant increase in weight gain was observed in control and experimental groups, the increase was more in the experimental group. When independent t-test was done a significant difference was not observed in body weight before and after the intervention. Regarding body mass index a significant difference was observed after intervention. ($p \leq 0.05$).

The mean difference in body weight in control and experimental groups are 1.49 kg and 4.75 kg respectively. The mean difference in body mass index in control and experimental groups are 0.6 $kg/m^2$ and 2.02 $kg/m^2$ respectively. The mean difference was more in the experimental group.

Effective tuberculosis therapy helps in weight gain which was observed in the control group. Nutritional supplementation along with therapy resulted in more weight gain in the experimental group compared to control group which was also evident from Table No.1 and 2. During experimentation, the supplement met 1/3 rd of the daily requirement for proteins and calories and ultimately helped in retaining lost tissue and there by resulting in more weight gain.

Wasting is the common feature of tuberculosis. Wasting usually comprises loss of fat and lean tissue. It is likely to have been caused by a combination of reduction in appetite leading to a decrease in energy intake, interacting with increased losses and altered metabolism as part of the inflammatory and immune response (Macallan *et al*, 1998; Paton, 1999) [7, 12] Wasting is associated with impaired physical function (Harries, 1988) [5] as well as increased mortality in patients with tuberculosis (Mehta *et al*, 1996; Rao *et al*, 1998; Zachariah, 2002) [8, 14, 17]. Although body weight increases during tuberculosis treatment, recovery may be slow and significant wasting can persist for months after the start of effective tuberculosis therapy. Hence nutritional supplementation is advocated along with anti-tuberculosis drugs to facilitate rapid recovery.

The increase in body mass index observed and recorded in the present study is consistent with the observations of Karyadi *et al*, 2002 and Paton *et al*, 2004 [6, 13]. The increase in body weight seen in the present study is on par with the findings of Fakultaskedokteran *et al*, 2004 [4].

### Effect of Supplementation on Sputum Conversion

The number of sputum smear conversions along with percentage of patients is presented in Table No.3.

**Table 3:** Number of Sputum Smear Conversions

| Time (week) | Experimental (n=60) | Control (n=60) |
|---|---|---|
| 0-2 | 38 (63) | Nil |
| 2-4 | 16 (90) | 24 (40) |
| 4-6 | 6 (100) | 12 (60) |
| 6-8 | Nil | 20 (93.3) |

The figures in '()' indicates percentages

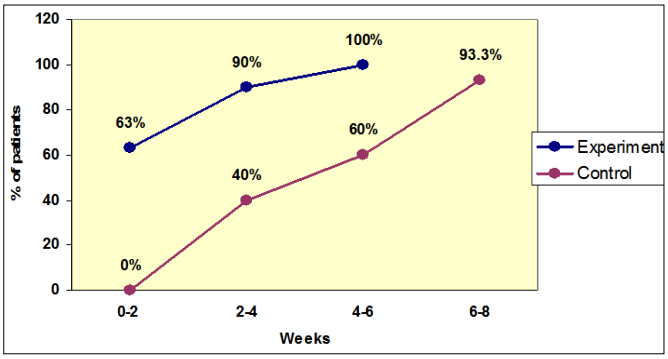



**Fig 4:** Percentage of patients with Sputum Conversion in control and experimental groups

After two weeks of nutritional supplementation, the number of patients with sputum smears negative for acid fast bacilli was 63 percent in the experimental group. In the control group no sputum smear conversions were observed for first two weeks. This difference was maintained for six weeks. Within six weeks, all the sputum smears in the experimental group turned negative for acid fast bacilli whereas in control group this was only up to 60 percent. Nutritional supplementation resulted in an earlier elimination of tubercle bacilli from sputum (fig.4).

Nutritional supplementation improved the effect of tuberculosis medication and cell-mediated immunity resulting in the earlier elimination of bacilli from sputum. Ragi, soyabeans and peanuts play a positive role in protecting a person against tuberculosis. Soyabeans improved the process of detoxification, decreased the inflammation and cell damage and also increased the tolerance of anti-microbial agents. Nitric oxide present in peanuts and arginine present in peanuts as well as soyabeans and glutamine present in soya beans enhanced the body's defense against tuberculosis. Since the food mixture consisted of soyabeans and peanuts, it enhanced the immunity and there by resulted in earlier sputum conversion.

After the intervention also sputum examination was again done for all the patients and recurrence was not observed. Since nutritional supplementation met 1/3rd of the daily requirement for proteins and calories, this has boosted up the body's defenses.

Faster sputum conversion would reduce the risk of tuberculosis transmission (a person with active tuberculosis will infect an average of 20-28 other persons before recovering from the disease or dying) (AHRTAG, 1996) [1]. It also helps in reducing the average dosage of antituberculosis drugs either in the first or second phase of treatment or to introduce a shorter regimen. Such a regimen would lead to a higher completion rate, fewer adverse drug effects, and lower cost of antituberculosis treatment. Similar results were obtained by Karyadi *et al*, 2002; Chandra *et al*, 2004 and Nursyam, 2006 [6, 3, 10] while supplementing health drinks and various nutrients to tuberculosis patient.

**Effect of Supplementation on Radiological recovery**

X-ray of the chest was done once monthly and at the end of the experiment to see the resolution of lesion area in both experimental and control groups. Some of the patients x-rays are presented which are showing major changes.

**X-ray of patient 1**

1A. is the x-ray of the patient before the experimentation. The x-ray shows cavity in the right upper zone with 5 cm diameter and wall thickness of 2-3 mm and multiple infiltrative lesions and areas of consolidation. Few infiltrates are also seen in left mid zone and right upper zone.

1B. is the x-ray after two months of treatment and nutritional supplementation. Resolution of the cavity is seen. The size of the cavity decreased to 3.5 cms and the thickness of the wall to 2mm. Infiltrates decreased in size and fibrosis is seen. Few calcifies are seen in left mid zone. Thick and horizontal fissure is seen in right side.

**X-ray of patient 2**

2A. is the x-ray showing dense confluent lesions in right upper and left mid zone. Zone of consolidation is seen in left para cardiac area with patchy pneumonitic changes.

2B. infiltrates decreased in size and no consolidation in lower zone is seen after two months of supplementation.

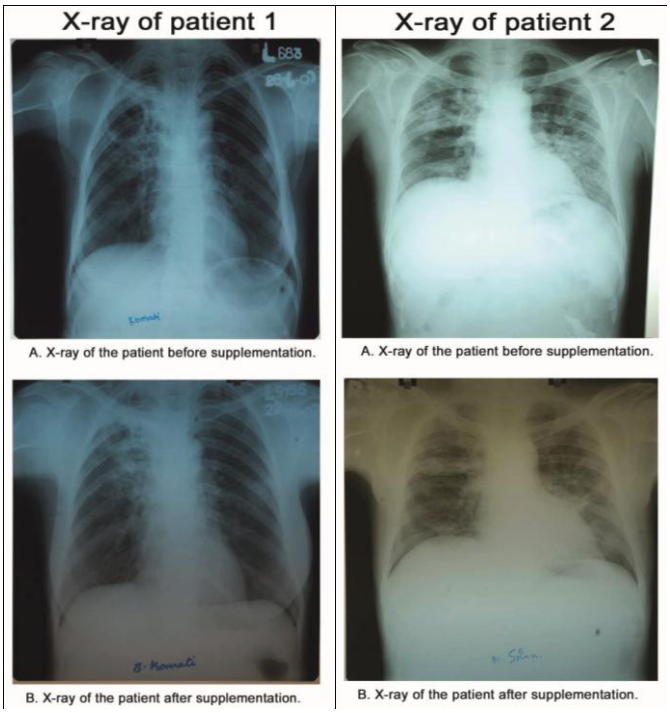
**X-ray of patient 3**

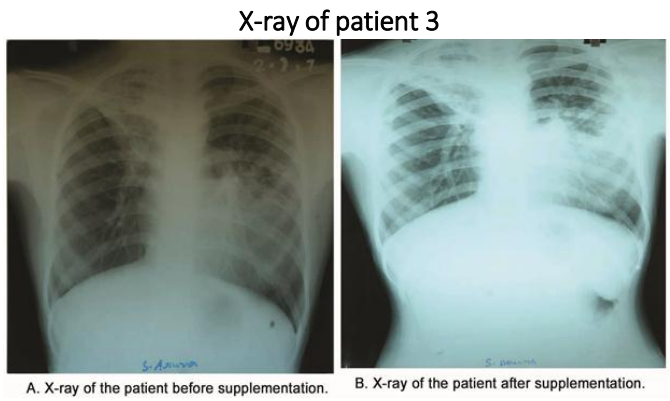
3A. shows homogenous opacity in the right upper zone with lymph adenopathy. Infiltration and area of consolidation is seen in right upper, left mid and lower zones.

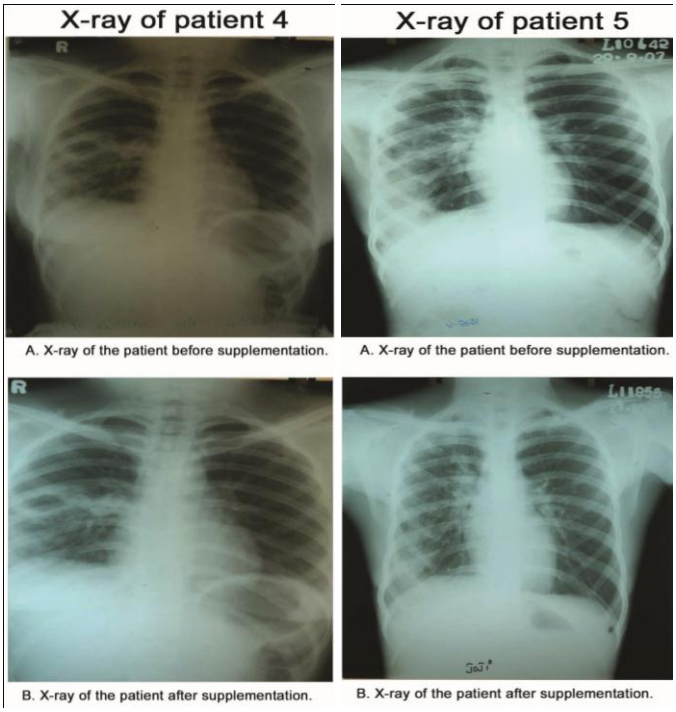
3B. after two months of supplementation right upper zone lesions decreased in size. Area of consolidation is seen in right upper zone, left mid and lower zone. Para tracheal lymph nodes decreased in size.

Photographs 1-3 are the X-rays of patients of experiment group. They showed early resolution of lesion areas. This was because of nutritional supplementation. The calcium present in ragi and soyabeans helped in healing of tuberculosis lesions. Whereas soyabeans decreased the inflammation and cell damage, there by resulting in early healing of lesions.

Photographs 4 and 5 are the X-rays of control group patients. Here no marked difference was observed after the intervention.






## Conclusion

It would be beneficial to include supplements along with current tuberculosis treatment regimens as shown in the study. Nutritional supplementation during the early stages of tuberculosis treatment could be beneficial in restoring physical function. Restoration of physical function might help to shorten the convalescent period and facilitate earlier return to productive work since tuberculosis tends to affect the poor, especially in under developed countries where people often depend on physically demanding manual labor for their income.

Malnutrition is associated with decreased survival in tuberculosis. More rapid reversal of malnutrition could also confer some survival benefits. Early restoration of nutritional status could also lead to immunologic changes that could enhance the clearance of Mycobacteria and reduce infection in patients. Reduction in infection would reduce the transmission of infection there by reducing the prevalence.

Hence, the need for nutritional supplementation should be high lightened along with treatment through drugs, which is not often done.

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