Nutritional Status of Tuberculosis Patients in Oyo State Nigeria from 2020 to 2021

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ABSTRACT

***Background:** Pulmonary Tuberculosis (TB) is a serious infectious respiratory illness with a significant incidence in underdeveloped nations, including Nigeria. As a result of these; goals were set for the research to show the importance of proper nutrition in the treatment, and control of tuberculosis; as well as see how, diverse indigenous native protein foods consumed in their local community can enhance a Tuberculosis patient's nutritional wellbeing and recovery.*

***Method:** A descriptive research design was used to conduct this study. The weight (kg) and Height (m) of 120 patients used for the study was taken and their Body Mass Index calculated. Eighty three patients were given treatment, 12 patients were infants, and 19 patients were used for control while a total of 5 patients were lost during the study due to mortality. Blood samples were collected from these patients and a GeneXpert analysis as well as a tuberculin skin test to confirm tuberculosis infection was conducted. Radiographic analysis (Chest Xrays) was conducted for all the patients and then a diet chart plan incorporating indigenous protein sources was recommended for the patients having in mind the recommended protein allowance for these tuberculosis patients. Statistical Analysis was done using SPSS version 25.*

***Results.** More than half (80%) of the patients that were given the indigenous protein diet comprised of 59 Male and 37 females. 15.83% of the control group weren't given these indigenous protein diet. These patients were monitored using their body weight as well as their Body Mass Index. A significant increase in weight was seen in 80% of TB patients given indigenous protein diet and drug treatment, $p < 0.05$) as well as recovery was observed at the end of the study, while the control TB Patients weight had ($p > 0.05$), and recovery was quite slow. The TB infants' patients who were also given the indigenous protein diet and drug treatment had their weight increased having ($p < 0.05$). The recovery rate of tuberculosis patients who were given the indigenous protein diet treatment alongside their regular TB medicines recovered significantly throughout the study. Nutritional counseling following recovery facilitated their quick recovery and helped avoiding relapse with tuberculosis.*

***Conclusion:** Indigenous protein food sources represents a novel approach for fast recovery in tuberculosis patients.*

Keywords: Nutrition, Tuberculosis, Body Mass Index

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INTRODUCTION

The bacillus Mycobacterium Tuberculosis. 1 is the source of the infectious disease tuberculosis (TB), which most frequently affects-the-lungs. (Pulmonary TB) and spreads when individuals with pulmonary TB expel the bacteria into-the-air (1, 2). When TB is reactivated after lying dormant in a person for years, it can cause severe systemic symptoms (3). Taking over HIV/AIDS, this infectious disease is one-of-the top 13 global causes-of-death. This infectious disease is among the 13 leading causes of death worldwide (4, 5). According to the World Health Organization, about 10.6 million were infected with Tuberculosis in 2021, and 2.2 million cases were attributed to undernutrition (6).

The risk of progression from exposure to the development of active disease is a two-stage process controlled by both exogenous and endogenous risk factors (7). Exogenous factors play a key role in enhancing the progression of tuberculosis from exposure to infection which the bacillary load in the sputum and the proximity of an individual to an infectious Tuberculosis case are key factors (7). Similarly, endogenous factors lead in progression from infection to active Tuberculosis disease (8). Research conducted in the previous years has shown certain risk factors which include human immunodeficiency virus (HIV), as well as malnutrition which play a significant role at both the individual and population level (8).

Nigeria comes third behind only India and China in terms of tuberculosis cases. Every year, around 245,000 Nigerians die from tuberculosis (TB) and about 590,000 new cases occur (of these, around 140,000 are also HIV-positive). TB accounts for more than 10% of all deaths in Nigeria. Every hour, nearly 30 people die from the disease, despite effective treatments being available (12).

A target of 90% and 95% reduction in TB incidence and TB-related mortality by 2035 was set by the WHO in 2015 (9) however only 20% TB incidence was achieved in 2020 (6, 10). Nutrition has been found to play a great role in the recovery of tuberculosis patients; and when vitamin A and Zinc are deficient, they increase the risks associated with tuberculosis infection (13). This novel approach (use of indigenous protein food sources) alongside with DOT therapy in the treatment of tuberculosis has accounted for a fast recovery in tuberculosis patients; and in addition to raising the nutritional status of a population has proved to be an effective measure in controlling tuberculosis in underdeveloped countries like Nigeria

MATERIALS AND METHODS

Data Collection

Primary data collection was performed through face-to-face interviews. Tools for the data collection were a structured questionnaire that was used for assessment, checklist (patient treatment card), bathroom scale weighing machine for weight measurement, height meter for height measurement, and locally available cups, plates, and glasses for measuring the amount of food consumed, all these were measuring anthropometric indicators.

Sample Collection

Samples were collected from active tuberculosis patients who were currently admitted in the recognized tuberculosis hospital (General Hospital Ibadan) and their data was collected using the National Tuberculosis control Programme Nigeria standard format. Also, their anthropometric measurement was also taken using the ABC guide in Nutrition assessment (14).

Diagnostic Criteria

According to the diagnostic criteria for Pulmonary Tuberculosis issued by the National Tuberculosis control Programme Nigeria which is also approved by the World Health Organization, pulmonary Tuberculosis patients should meet the following criteria: 1) suggested TB symptoms (e.g., cough for more than 2 weeks or hemoptysis), 2) sputum specimens smear-positive for acid-fast bacilli, 3) negative sputum smears but with pulmonary lesions on chest radiographs (15).

Diagnostic Methods

Samples (sputum, Blood) were collected from the patients, biochemical analysis was performed on the samples such as the sputum test, GeneXpert analysis (16) microbial analysis (17) as well as radiographic (X-ray) analysis (18).

Statistical Analysis

Data are presented as mean ± S.E.M. The statistical analysis was done using SPSS version 25 and Excel 2010. * refers to $p < 0.05$, as compared to control and ** refers to $p > 0.05$ as compared to diet treated tuberculosis patients.

OBSERVATION & RESULTS

Diet Chart

Table 1. Diet Chart of Indigenous Meals as Well as Indigenous Protein Sources.

S/No.	List of Indigenous Protein Sources	Protein Content (g)	Recommended Amount of Protein (g)	Recommended Indigenous Meals
1	African Oil-bean (Ugba) (20)	36.2g - 43.89g	3.42g	Locust Beans vegetable with smoked fish + Boiled Yam
2	Locust Bean (Iru) (Iru woro & Iru Pete) (21)	35g	4.3g	Beans Porridge (Ewa Agonyi) + Agidi (Maize Pudding)
3	Smoked Fish (22)	18g	8.3g	Dried Fish Pepper Soup + Agidi (Maize Pudding)
4	Dry Fish (23)	62g	2.4g	Beef Stew + Boiled Rice + Vegetables
5	Beef (Steak) (24)	26g	5.8g	Beef Vegetable Soup + Amala/Semo/Wheat + Pepper stew
6	Chicken (25)	27g	5.5g	Smoked Fish stew + Ewedu + Amala/Semo/Wheat
7	Prawns (26)	24g	6.3g	Dried Fish Stew + Okro soup + Amala/Semo/Wheat
8	Fresh Fish (Mackerel) (27)	19g	7.9g	Prawns Vegetable Stew + Boiled Plantain
9	African Brown Beans (Cowpea) (28)	15.62g – 17.91g	8.4g	Akara (Beans Cake) + Pap
10	Bambara Beans (29)	70.85g	2.1g	Okpa + Pap
11	African Smoked Crayfish (30)	66.34g – 66.84g	2.2g	1 boiled Egg + Tomato Stew + Plain boiled Rice
12	African Brown Egg (31)	12.6g	11.9g	Iru Jellof Rice + Vegetables

The diet chart used for the diet treatment of 83 Tuberculosis patient contained indigenous protein of both animal and plant sources. These protein sources were readily available as well as affordable for the patient if he/she needs further follow-up on the diet when they get home. These protein sources have been tested and results are documented in scientific journals to attest to their rich protein source (Table 1).

Weight Distribution Tuberculosis Patient's (Control Rx vs Diet+ Rx)

Table 2a T Test analysis comparing Pre weight and Post weight of 19 Control TB Patients.

	Control (Rx Only) Initial Weight	Control (Rx Only) Post-weight
Mean	54.63	51.95
Variance	131.80	74.94
Observations	19	19
Pearson Correlation	0.56	
Hypothesized Mean Difference	0	
Df	18	
t Stat	1.19	
P(T<=t) one-tail	0.12	
t Critical one-tail	1.73	
P(T<=t) two-tail	0.25	
t Critical two-tail	2.10092204	

20 Tuberculosis patients were used for the control study and 1 patient expired during the course of the study Comparing both weights using the T-test for paired sample for Mean the initial weight was 54.63 having a variance of 131.80 and the final weight having a mean of 51.95 and a variance of 79.94 showing a significant decrease (Table 2a).

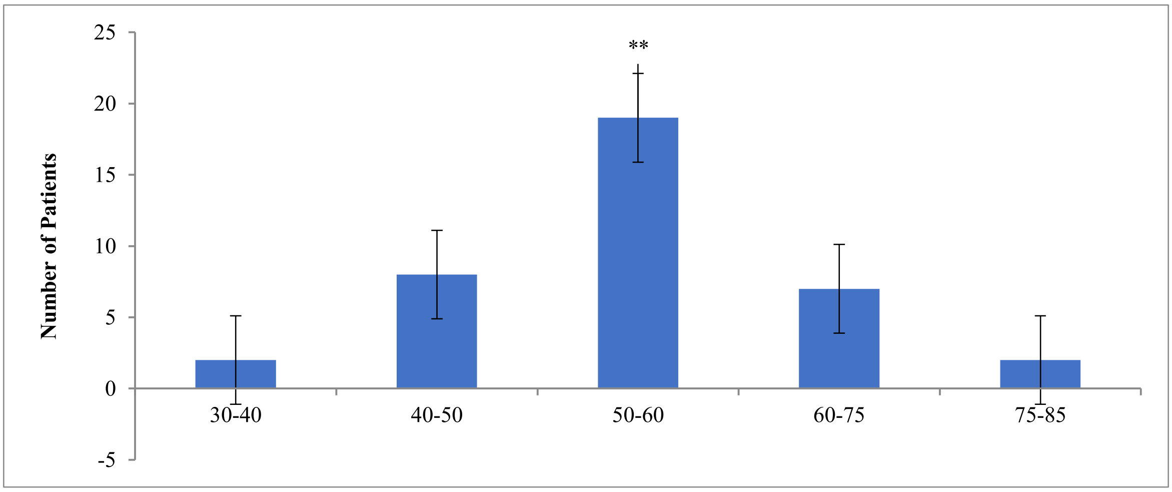

Figure1a. Histogram Showing the Weight distribution of Control Patients

The *p* values > 0.05 which is considered statistically insignificant was observed. Also, from the weight range we had more of the Tuberculosis patients fall into the 50-60kg category as seen in the plotted histogram chart showing the weight distribution (Figure 1[a]).

Table 2b. T-Test Analysis Comparing Pre and Post-Weight of 83 TB Patients (Rx + Diet).

	Patients (Rx + Diet) Initial Weight of the Patient (Kg)	Patients (Rx + Diet) Weight after Treatment (Kg)
Mean	55.42	59.87
Variance	189.73	175.36
Observations	83	83
Pearson Correlation	0.98	
Hypothesized Mean Difference	0	
Df	82	
t Stat	-15.17	
P(T<=t) one-tail	**8**.03E-26	
t Critical one-tail	1.66	
P(T<=t) two-tail	1.6065E-25	
t Critical two-tail	1.99	

Furthermore, 87 Tuberculosis patients was used for the treatment study and 4 patients expired during the course of the study leaving us with a total of 83 patients left after the study. Comparing both weights using the T-test for paired sample for Mean the initial weight was 55.42 having a variance of 189.73 and the final weight having a mean of 59.87 and a variance of 175.36; we can see a significant increase in the final weight of the treated patients. Also, the *p* value < 0.05 which is considered statistically significant was observed (Table 2b).

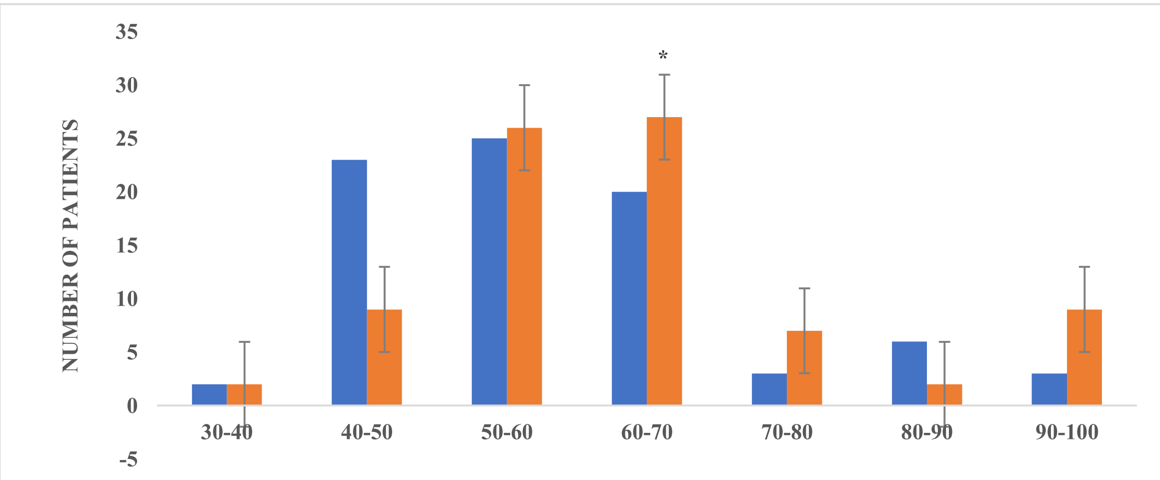

Figure 1b Clustered Column chart of Pre and Post-weight average of 83 TB Patients (Rx + Diet).
Also, from the clustered column graph plotted, we can see there was a gradual increase in the weight of the treated patients; as they moved from the 40kg to 70kg (Figure 1[b]).

Body Mass Index of Tuberculosis Patients Used for the Study

Table 3. Showing the t-Test Paired Two Sample for Means of the Control Patient (Rx Only).

t-Test: Paired Two Sample for Means	BMI (0) (kg/m2)	BMI (1) (kg/m2)
Mean	22.65	21.5
Variance	28.15	16.17
Observations	19	19
Pearson Correlation	0.64	
Hypothesized Mean Difference	0	
Df	18	
t Stat	1.21	
P(T<=t) one-tail	0.11	
t Critical one-tail	1.73	
P(T<=t) two-tail	0.24	
t Critical two-tail	2.10	

Body mass index is a vital indicator that measures the body fat based on height and weight of adult. In infants we measure their percentile, it's also a vital indicator that shows that the child is growing properly. From the control tuberculosis patients (Rx only) p value was > 0.05 which is regarded as statically insignificant (Table 3).

Table 4a T Test analysis comparing Pre and Post BMI of 83 TB Patients (Rx + Diet)

	BMI 0 (kg/m2)	BMI 1 (kg/m2)
Mean	21.17	22.49
Variance	7.62	9.87
Observations	83	83
Pearson Correlation	0.27	
Hypothesized Mean Difference	0	
Df	82	
t Stat	-3.34	
P(T<=t) one-tail	0.000631959	
t Critical one-tail	1.66	
P(T<=t) two-tail	0.001263919	
t Critical two-tail	1.98	

Tuberculosis Patients who were treated with (Rx + Diet) had a p value < 0.05 which is also regarded as statistically significant (Table 4a).

Table 4b. T-Test analysis of TB-Infants patients (Rx + Diet) Initial and Final BMI.

	BMI 0 (kg/m2)	BMI 1 (kg/m2)
Mean	10.41	17.23
Variance	10.62	0.02
Observations	12	12
Pearson Correlation	0.74	
Hypothesized Mean Difference	0	
Df	11	
t Stat	-7.52	
P(T<=t) one-tail	5.86E-06	
t Critical one-tail	1.79	
P(T<=t) two-tail	1.17E-05	
t Critical two-tail	2.20	

Infant tuberculosis patients who were treated with (Rx + Diet) had their body mass index measured in percentile and after analysis p value was < 0.05 which makes it statistically significant (Table 4b).

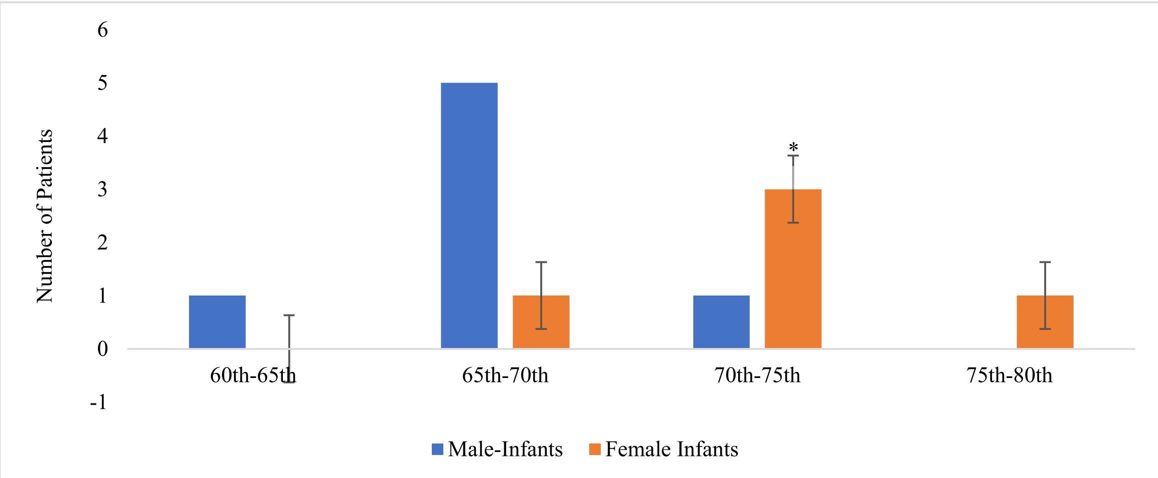

Figure 2. Clustered Column showing the percentile BMI range for both Male and Female Infants.

A cluster column shows the distribution of infant male and female BMI (Figure 2).

TB-Infants patients (Rx + Diet) initial weight and Final weight

Table 2c. T-Test analysis comparing Pre and Post-weight of TB-Infants Patients (Rx + Diet).

	Pre-weight of TB-Infants (Kg)	**Post weight of TB-Infants (Kg)**
Mean	5.42	7.67
Variance	8.27	12.56
Observations	12	12
Pearson Correlation	0.99	
Hypothesized Mean Difference	0	
Df	11	
t Stat	-9.95	
P(T<=t) one-tail	3.89E-07	
t Critical one-tail	1.79	
P(T<=t) two-tail	**7.**77E-07	
t Critical two-tail	2.20	

13 Tuberculosis Infant patients were used for the treatment study and 1 patient expired during the course of the study leaving us with a total of 12 infant patients left after the study. Comparing both weights using the T-test for paired sample for Mean the initial weight was 5.42 having a variance of 8.265 and the final weight having a mean of 7.67 and a variance of 12.56; we can see a significant increase in the final weight of the treated infant patients. Also, the *p* value < 0.05 which is considered statistically significant (Table 2c).

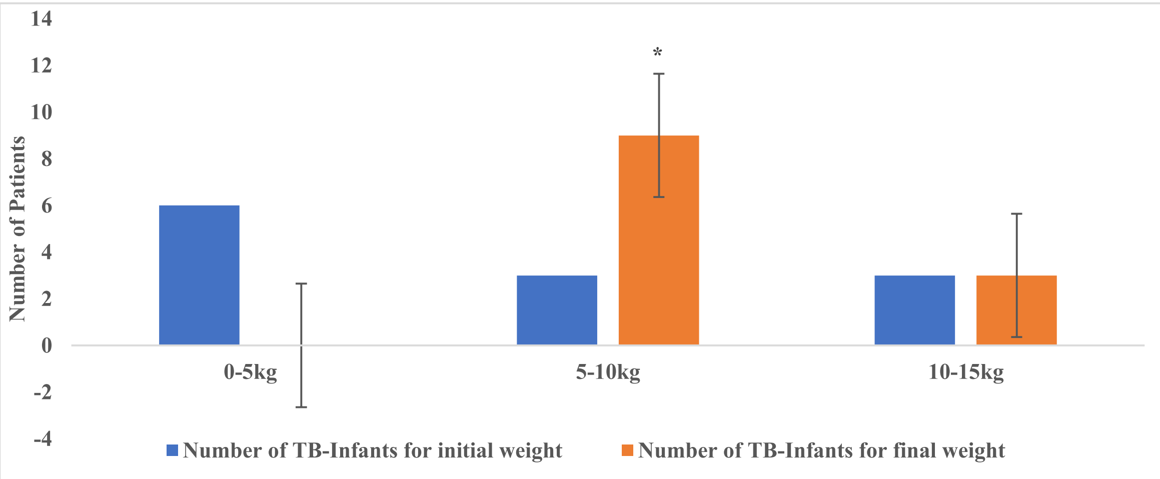

Figure 3: Showing the Clustered Column chart of Pre- and Post-weight average of TB-Infant Patients (Rx + Diet)

Also, from the clustered column graph we can see a gradual increase in the weight of the treated infant patients; they moved from the 5kg to 10kg and above (Figure 3).

Recovery Weight of Tuberculosis patients (Control Rx vs Diet+ Rx)

Table 5. ANOVA Test comparing 83 Tuberculosis patients (Rx + Diet) vs Control (Rx) Recovery.

Groups	Count	Sum	Average	Variance		
Control Rx Recovery	19	36	1.89	0.32		
83 patient's Rx + Diet Recovery	83	81	0.98	0.02		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	13.05	1	13.05	168.61	3.49E-23	3.94
Within Groups	7.74	100	0.08			
Total	20.79	101				

Comparing the recovering rate among 83 tuberculosis patients who received treatment and 19 control patients; ANOVA was used to analyses this comparisms; and between groups the *p* value < 0.05 shows that it's statistically significant (Table 5).

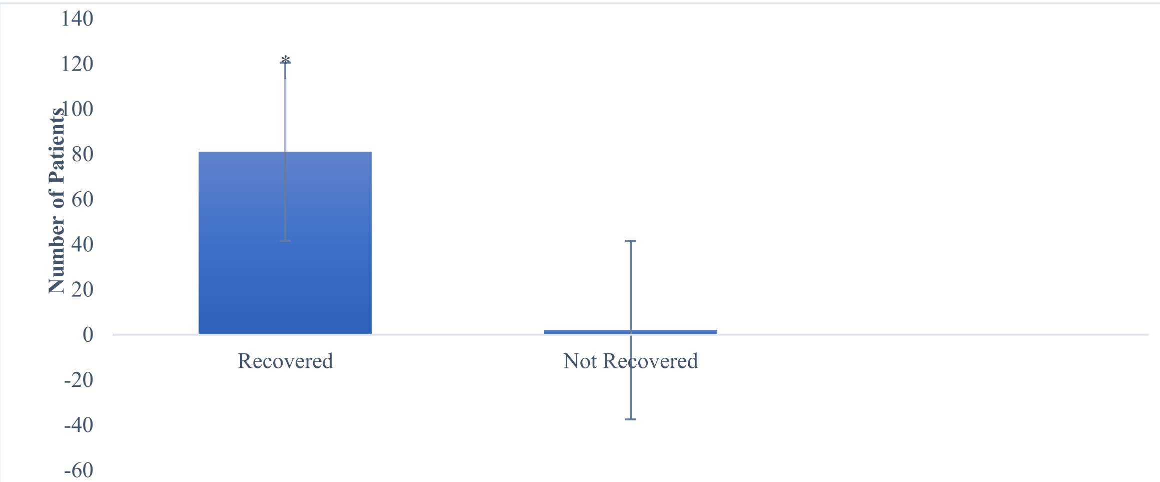

Figure 4a: Showing the Histogram of Recovery of 83 TB Patient (Rx + Diet)

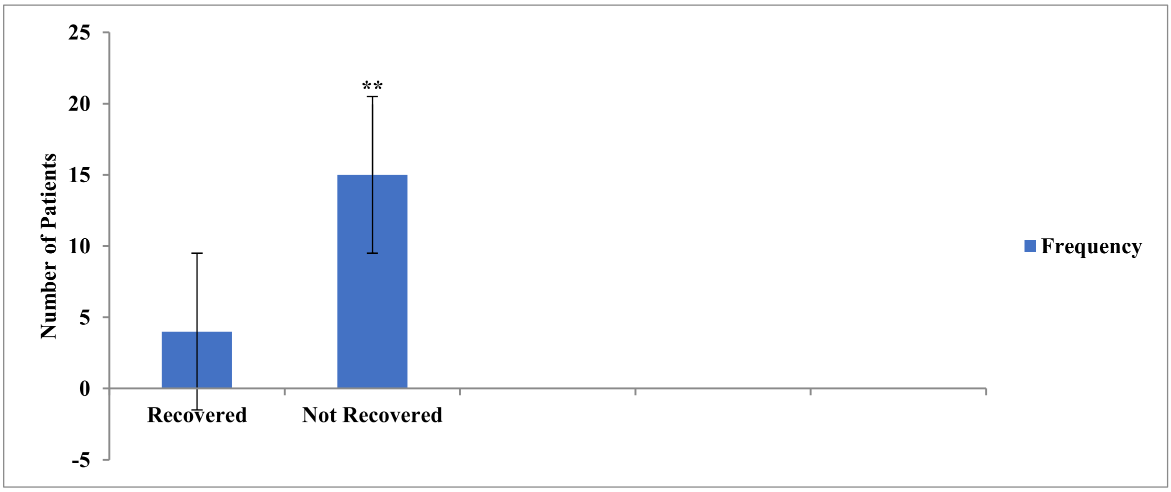

Figure 4b. Showing the Recovery of Control Patients (Rx Only)

The effect of the diet was significantly seen in the 83 tuberculosis patients. 81 recovered fully having a cumulative of 97.59% while 2 (2.41%) were still at the process of recovering. While the control patients had a greater percentage of tuberculosis patients 15 were still in the process of recovering. Only 4 patients recovered. This is shown in the histogram chart (Figure 4[a] & 4[b]).

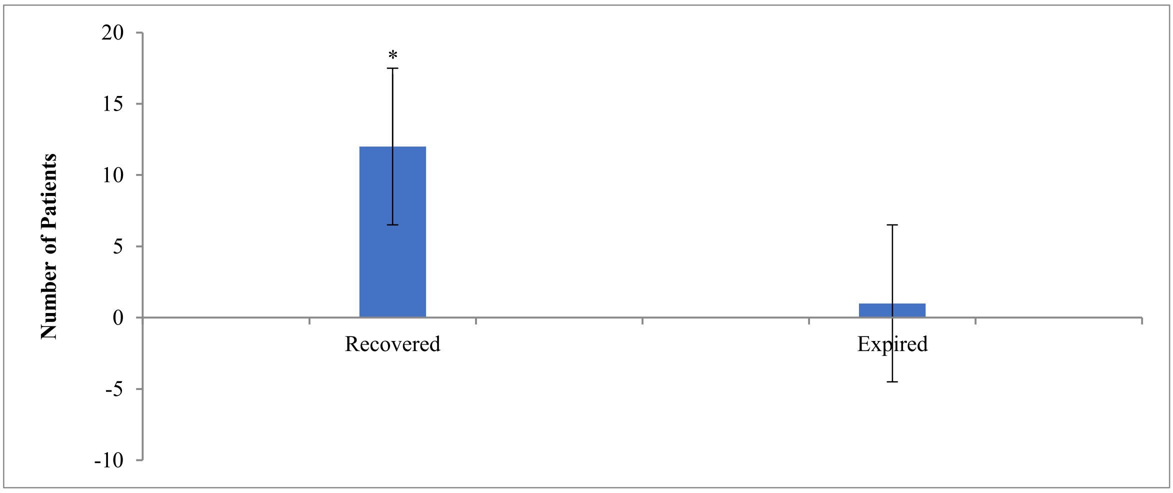

Figure 4c. Showing the Recovery of TB-Infants Patients (Rx + Diet).

A greater percentage of the tuberculosis Infant patients 12 (92.31%) recovered. Only 1Infant patients was still recovering. This is shown in the histogram chart (Figure 4[c]).

HIV Status of Tuberculosis Patients Used for the Study

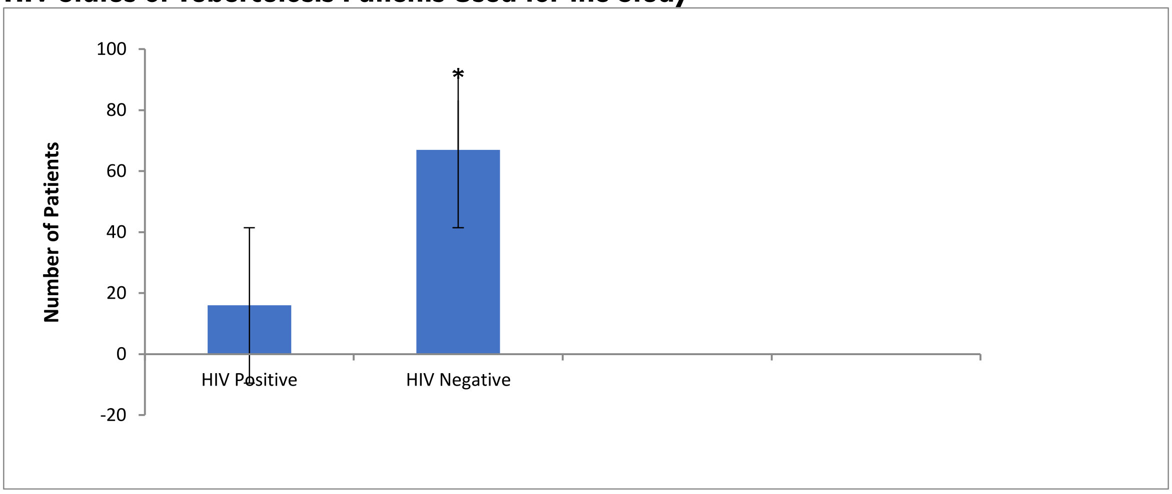

Figure 5a. Histogram showing % HIV-positive and Negative in Control (Rx Only) TB Patients
Majority of the patients used for the study were HIV Negative. For the control (Rx Only) tuberculosis Patients, 89.47% were HIV negative (Figure 5[a]).

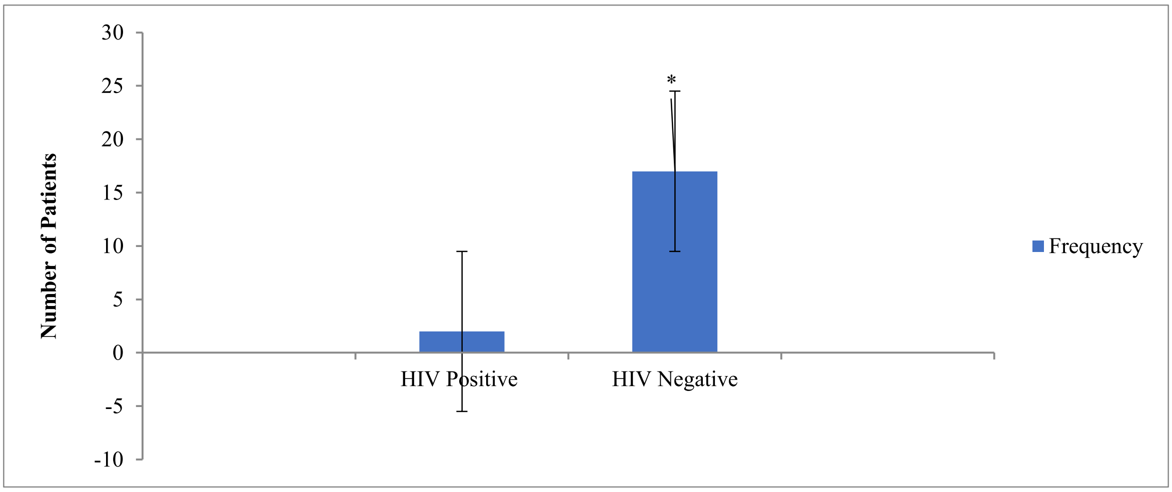

Figure 5b. Histogram showing % HIV-positive and Negative in 83 Patient (Rx + Diet) TB Patients.

While Patients treated with (Rx + Drug) had 80.72% of the patient's HIV negative (Figure 5[b]).

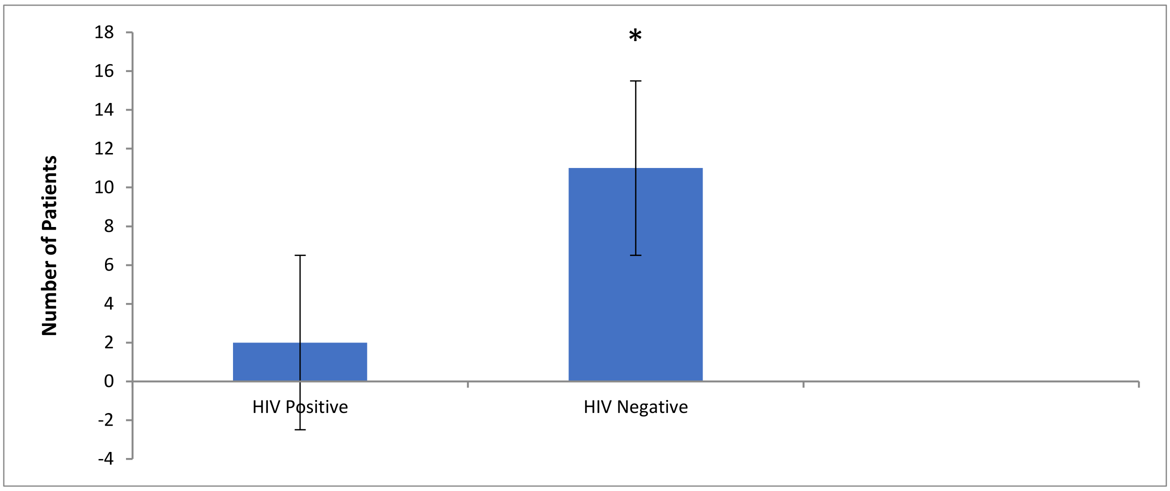

Figure 5c. Histogram showing % HIV-positive and Negative in TB-Infants Patients (Rx + Diet). Infant TB patients had 84.62% of the patient's HIV negative (Figure 5[c]).

DISCUSSION

Worldwide, Tuberculosis is the 13th leading cause of death and the second leading infectious killer after COVID-19 (above HIV/AIDS). In 2020, an estimated 10 million people fell ill with tuberculosis (TB) worldwide. 5.6 million men, 3.3 million women and 1.1 million children. Tuberculosis is present in all countries and age groups and has existed for thousands of years and has affected mankind; and is still been reported by the World health organization (6, 19), But Tuberculosis is curable and preventable. Child and adolescent Tuberculosis is often overlooked by health providers and can be difficult to diagnose and treat; In 2020, 30 high TB burden countries accounted for 86% of new TB cases. Eight countries account for two thirds of the total, with India leading the count, followed by China, Indonesia, the Philippines, Pakistan, Nigeria, Bangladesh and South Africa. (32). Every hour, nearly 30 people die from the disease, despite effective treatments being available in Nigeria. Moreover, diagnosis is not always easy, and treatment takes several months; in the meantime, loss of earnings for the sufferer may drive families into poverty, multiplying the burden of the disease (33). So many experimental drug designs on antibiotics has been put in place to combat this infectious disease, but the bacterial strain keeps making copies of the drugs thereby making it resistant as the years go by (34). The aspect of introducing nutrition has not been carefully considered knowing that protein is the major nutrient deficient in a tuberculosis patient (35); therefore, the role of nutrition and use of indigenous protein-rich foods in managing tuberculosis infection is very important in the management of Tuberculosis.

This prompted the need to conduct this study using indigenous protein sources that is easily accessible and affordable as well as rich in essential amino acids that play a vital role in the aiding the recovery in tuberculosis positive patients used for the study from 2018-2020. A total of 120 patients was used for the study; 20 patients were randomly selected and used for the control; they were given only their tuberculosis medication while 100 patients were administered the diet treatment alongside the tuberculosis medications. 5 patients died on the course of the study leaving us with 95 tuberculosis patients for the diet treatment of which 12 were infants and 19 control tuberculosis patients after the study.

The tuberculosis patients used for the control who were administered the first line tuberculosis drugs had a very slow recovery. Research has shown that these drugs have their side effects which obvious will affect their recovery progress (36). Their weight did not increase as seen from the study which also affected their body mass index; and when analyzed statistical, the *p* value was > 0.05 making it statistically insignificant. Studies has shown that tuberculosis patients administered drugs only are 11 times more likely to have a body mass index < 18.5 which is an indicator of poor nutrition (37). Finally, adverse reactions of anti-tuberculosis drugs are risk factors for malnutrition, independent of age, gender, education, occupation, and access to food stuffs (38).

Tuberculosis patients who were given the diet treatment alongside their drugs had a great improvement in their weight which also reflected in their body mass index and when statistical analyzed had p value < 0.05 which makes it statistically significant.

Moreso in the study we had infant tuberculosis patients who were administered the diet treatment as well alongside with their mothers giving the breastmilk which helped in the recovery of the infants in their weight which when analyzed statistically had p value < 0.05 as well as percentile between 65th and 85th mark. Maternal nutrition and her ability to confer protection have large implications on the development of a functional innate immune system in the child which is very important to fight tuberculosis infection (39). Although studies have not been conducted to determine how dysfunction in immune development impacts risk of pediatric tuberculosis, this evidence supports that without adequate early nutrition, appropriate immune development is greatly impaired and places the child at considerable risk (40).

A study found that a large proportion (46%) of the early weight gain comprised in the recovery of the lean tissues which restores physical functions more rapidly, confirming the findings that tuberculosis can mount a protein anabolic response on feeding, therefore the role of nutrition is very essential in the improvement as well as recovery of tuberculosis patients (41). Therefore, early restoration of nutrition could also lead to immunologic changes that could enhance the clearance of mycobacteria and reduce infectiousness of a tuberculosis patient.

CONCLUSION

This approach in the use of indigenous protein food sources may represent a novel approach in research for fast recovery in tuberculosis patients owing to the fact that the indigenous proteins are money friendly, easily accessible and readily available in rural and urban market. Moreso, these indigenous protein aid greatly in improving the nutritional status of a population and may also prove to be an effective measure to control the widespread tuberculosis incidence in underdeveloped and developing countries like Nigeria.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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