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Research Article

Socio-Demographic Parameters and Effect of Nutritional Intervention on TB Patients in Jos, Plateau State, Nigeria

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Abstract

Background: Undernutrition significantly heightens the risk of TB infection progressing to active TB, mortality, and disease relapse. It also complicates the management of tuberculosis. Therefore, this study aims to assess the prevalence and factors influencing undernutrition among TB patients in Jos, Plateau State, Nigeria. Additionally, the study will evaluate the impact of nutritional intervention using ready to use functional foods.

Method: The study adhered to ethical principles outlined in the Helsinki Declaration, obtaining ethical clearance and consent from the relevant centres. A systematic random sampling method was employed, resulting in a sample size of 161 patients selected using Probability Proportional to Size (PPS) across various sites.

Adults aged 18 and above attending TB clinics were categorized into intervention groups A, B, and C, with group D serving as the control. Data on socio-demographic characteristics and feeding practices were collected using a structured questionnaire at both baseline and midline (month three) stages of the study.

Results: The study population included 161 adults aged 18-70 years, comprising 112 males (70%) and 49 females (30%), with an average age of 36.4 ± 10.7 years. The majority affected were in the age range of 18 to 44 years (80.1%). Among the widowed individuals, females constituted 62.5%, whereas males were 37.5%. A significant portion, 89 (55.3%), identified themselves as alcohol consumers, and 101 (62.7%) reported being smokers. Initially, 107 (66%) subjects reported consuming three meals daily, increasing to 126 (85%) during the midline assessment, while those consuming two meals decreased from 35 (22%) to 17 (11%).

Conclusion: Statistical analysis revealed a significant difference in mean weight and BMI between baseline and midline assessments for Interventional Groups B and C, regardless of HIV status, as well as for Group A (HIV-negative individuals) ($p < 0.05$). However, no significant differences were observed in the control group.

Keywords: Socio-Demographic; Parameters; Nutritional; Intervention; TB Patients

Introduction

Tuberculosis (TB) remains a formidable global public health challenge caused primarily by Mycobacterium tuberculosis (MTB), predominantly affecting the respiratory system. It spreads through the air when infected individuals cough or sneeze, posing significant health risks worldwide. In 2022 alone, an estimated 10.6 million new TB cases were reported globally, marking a 4.5% increase from the previous year (1). This surge included a notable rise in drug-resistant TB cases, underscoring the growing complexity and urgency of TB management [1].

In 2023, TB also affected 10.6 million individuals globally, with a substantial impact on adults and children alike [2]. The disease burden is compounded by latent TB infections, estimated at 1.7 billion individuals globally, representing a reservoir for potential outbreaks [3].

In Nigeria, TB remains a critical health issue, with the country ranking among the top 10 globally with high TB burden [1]. In 2020, Nigeria reported staggering statistics, with TB claiming 18 lives every hour and 47 new active TB cases emerging each hour [4]. Within Plateau State, the situation is similarly severe, with 3,122 TB cases identified in 2012, predominantly affecting the productive age group of 15 to 54 years [5].

TB is closely intertwined with HIV, and people living with HIV facing a dramatically higher risk of TB. Moreso, Malnutrition exacerbates TB significantly by compromising immune responses and worsen the disease severity. Therefore, Malnutrition and TB share a complex relationship, each influencing the other in a vicious cycle, particularly in resource-limited settings characterized by poverty, overcrowding, and inadequate healthcare access [6].

Whereas, key indicators of TB, such as wasting, anaemia, and loss of lean and fat mass, overlap with signs of malnutrition, amplifying health risks [6]. Thus, addressing malnutrition is therefore pivotal in TB management to enhance immune response and treatment outcomes.

This study aims to assess the prevalence and determinants of undernutrition among TB patients in Jos, Plateau State, Nigeria, while evaluating the effect of nutritional interventions using indigenous functional foods on socio-demographic parameters. By understanding these dynamics, effective strategies can be developed to mitigate the dual burden of TB and malnutrition in affected populations.

Materials and Methods

Data collection

Primary data were collected through face-to-face interviews using a structured questionnaire. Additionally, a checklist based on patient treatment cards was utilized. Anthropometric measurements included weight and height, which were recorded using a weighing scale machine and a standiometer, respectively.

To assess nutritional intake, each participant in the interventional groups (Group A, Group B, and Group C) received specific ready to use functional foods with their meals. Group A received antioxidant nutraceuticals one capsule a day. Group B received 40g of date powder per day, while Group C received locally formulated ready-to-use soy powder 50g per day. These functional foods were carefully selected and processed into a ready to use form and weighed to accurately measure the amount consumed and to evaluate their impact on anthropometric indicators and dietary intake among the study participants.

The use of these ready to use functional foods was integral to the study's methodology, ensuring precise measurement and standardization across the intervention groups. This approach aimed to assess how different nutritional interventions influenced the nutritional status and socio-demographic parameters of TB patients in Jos, Plateau State, Nigeria. The study employed systematic random sampling across multiple TB clinics in Jos, Plateau State, Nigeria, ensuring representation from diverse demographic backgrounds. Data collection occurred at two stages: baseline and midline (three months into the intervention period), allowing for comprehensive assessment of nutritional status and its impact on socio-demographic parameters among TB patients.

Ethical guidelines as per the Helsinki Declaration were strictly adhered to, with ethical clearance obtained from relevant authorities. Informed consent was obtained from all participants before data collection commenced. Quality control measures were implemented to ensure the accuracy and reliability of collected data throughout the study period.

Diagnostic Methods: Samples, including sputum and blood, were collected from the patients. Biochemical analyses such as sputum testing, GeneXpert analysis, microbial analysis, and radiographic (X-ray) examinations were conducted [7-9].

Statistical Analysis Data are presented as mean ± standard error of the mean (S.E.M.). Statistical analysis was performed using SPSS version 25 and Microsoft Excel 2010 as database. In the study $p < 0.05$ shows statistical significance from t-test and other statistical test comparing the control group with patients treated with diet interventions.

Results

Table 1 illustrates the socio-demographic characteristics of the study participants based on gender, occupation, and marital status. A majority of the participants (69.6%) were male. The mean age (SD) of the participants was 36.4 (10.7) years. Regarding age distribution, 58% of the participants belonged to the youthful productive age group. In terms of marital status, 77 (47.8%) of the participants were single, while 68 (42.2%) were married. A smaller proportion included widowed and divorced individuals, each comprising 8 (5%). In terms of occupation, 46 (28.7%) participants were low-income artisans, 38 (23.6%) did not have regular jobs, and 11 (18%) were farmers.

Table 2 presents the gender breakdown of the volunteers by age group and educational status. The age group 35-44 years comprised the highest number of volunteers (58), with 35 (87%) males and 23 (39.7%) females. The next highest group was aged 25-34 years, totaling 55 volunteers, consisting of 42 (76.4%) males and 13 (23.6%) females.Those aged 55-64 years numbered 5, with 4 (80%) males and 1 (20%) female. Volunteers above 65 years were 3, all of whom were males. The majority of volunteers had secondary education (64%), with 46 (71.9%) males and 18 (28.1%) females. Those with tertiary education numbered 45, comprising 30 (66.7%) males and 15 (33.3%) females. Volunteers with primary education totaled 40, with 28 (70%) males and 12 (30%) females. Those with non-formal education were 12, with 8 (66.7%) males and 4 (33.3%) females. The study recruited 46 artisans, predominantly males (91.3%). Trading activities involved 28 volunteers,

Variable	Group	Frequency (n = 161)	Percentage (%)
Age (Years) Mean ± SD (36.4 ± 10.7)	15-24	21	13.0
	25-34	50	31.1
	35-44	58	36.0
	45-54	24	14.9
	55-64	5	3.1
	65 +	3	1.9
Gender	Male	112	69.6
	Female	49	30.4
Occupation	Unemployed	18	11.2
	Civil servant	19	11.8
	Artisan	46	28.6
	Farmer	11	6.8
	Trader/Business	29	18.0
	Others	38	23.6
Marital status	Divorced	8	5.0
	Married	68	42.2
	Single	77	47.8
	Widowed	8	5.0

Table 1: Socio-demographic parameters of the respondents.

evenly split between males and females (50% each). Farmers consisted solely of males (11, 100%), reflecting the male-dominated nature of this occupation. Unemployed volunteers numbered 18, with 10 (55.6%) males and 8 (44.4%) females. Overall, the data indicate a gender disparity across educational and occupational categories, with males predominating in higher education and certain occupations like artisans and farming.

	Group	Male (n = 112) Freq (%)	Female (n = 49) Freq (%)	Total (n = 161) Freq (%)
Age (Years)	15 – 24	8 (50.0)	8 (50.0)	16 (100.0)
	25 – 34	41 (74.5)	14 (25.5)	55 (100.0)
	35 – 44	35 (60.3)	23 (39.7)	58 (100.0)
	45 – 54	21 (87.5)	3 (12.5)	24 (100.0)
	55 – 64	4 (80.0)	1 (20.0)	5 (100.0)
	65 +	3 (100.0)	0 (0)	3 (100.0)
Educational Status				
	Non-Formal	8 (66.7)	4 (33.3)	12 (100.0)
	Primary	28 (70.0)	12 (30.0)	40 (100.0)
	Secondary	46 (71.9)	18 (28.1)	64 (100.0)
	Tertiary	30 (66.7)	15 (33.3)	45 (100.0)
Occupation				
	Unemployed	10(55.6)	8 (44.4)	18 (100.0)
	Civil Servants	13 (68.4)	6 (31.6)	19 (100.0)
	Artisan	42 (91.3)	4 (8.7)	46 (100.0)
	Farmers	11 (100.0)	0 (0.0)	11 (100.0)
	Traders	14 (50.0)	14 (50.0)	28(100.0)
	Others	20(54.1)	17 (45.9)	37(100.0)

Table 2: Socio-demography of respondents by Gender.

Figure 1 depicts the distribution of recruited clients per hospital using the proportional to size sampling method. Faith Alive Foundation Hospital enrolled the highest number of subjects, with 58 individuals. Plateau Specialist Hospital followed closely with 42 subjects, while Bingham University Teaching Hospital and Jos University Teaching Hospital recruited 36 and 15 persons, respectively. Our Lady of Apostles Hospital had the fewest recruits, with 11 individuals. This distribution correlates with unpublished 2018 data on Tuberculosis in Plateau State, underscoring the referral roles of these hospitals. It provides valuable insight into the tuberculosis burden across Plateau State.

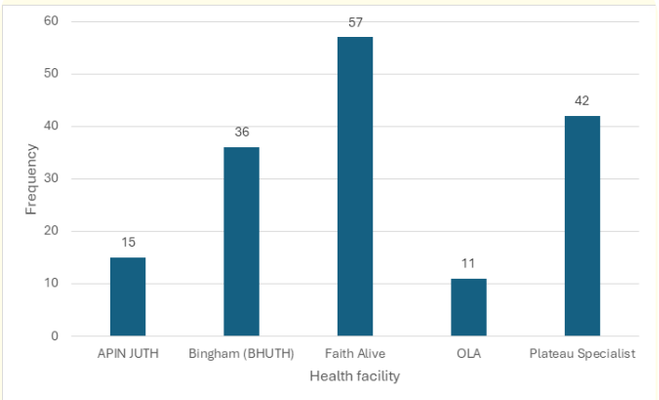

Figure 1: Number of Respondents Per Health Facility.

Based on the medical and social history presented in table 3, the study reveals that a significant majority, 98.1%, of respondents were actively undergoing TB medication, with varying durations: 40.99% for one month, 36.02% for two months, and 23.0% for three months. Additionally, a substantial proportion of volunteers, 36.6%, were HIV positive, while 60.9% tested negative for HIV, and 2.5% were unsure of their HIV status. Among the HIV-positive volunteers, 57 out of 59 were receiving antiretroviral treatment, indicating high adherence to HIV management protocols. Conversely, only 2 volunteers had not yet initiated antiretroviral therapy.

Regarding lifestyle factors, a notable portion of the participants reported regular alcohol consumption (55.3%) and cigarette smoking (62.7%). These findings underscore the complex health challenges faced by the study population, highlighting the need for comprehensive healthcare strategies and interventions.

Figure 2 depicts the economic status of the study participants based on their monthly income. Notably, approximately 25.55% of the participants reported having no monthly income. About 18% earned less than the minimum wage of N18,000.00, while another 13% earned exactly N18,000.00. In contrast, a small proportion, approximately 8.7%, reported earning more than N100,000 monthly. These findings highlight the predominantly low-income status of the TB patient population studied, indicating a high prevalence of poverty among them.

Variable	Group	Frequency	Percentage
Having TB medication	Yes	158	98.1
	No	3	1.9
	Total	161	100.0
Duration of TB medication	1	66	40.99
	2	58	36.02
	3	37	23.0
	Total	161	100.0
HIV status	Positive	59	36.6
	Negative	98	60.9
	Unknown	4	2.5
	Total	161	100.0
Having HIV medication	Yes	57	35.4
	No	2	1.2
	Total	59	36.6
Drink Alcohol	Yes	89	55.3
	No	72	44.7
	Total	161	100.0
Smoke Cigarette	Yes	101	62.7
	No	60	37.3
	Total	161	100.0

Table 3: Medical and Social History of Subjects in the Study.

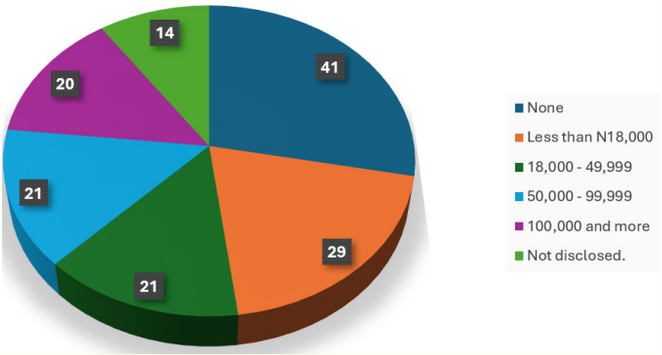

Figure 2: Average Incomes of Subjects in the Study.

Figure 3 presents the baseline meal frequency among the study participants. It reveals that 66% of the volunteers reported consuming three consecutive meals daily. Meanwhile, 22% indicated having only two consecutive meals daily. A small percentage, 5%, reported regularly eating dinner, and the same percentage reported having only lunch regularly. Only 1% of the participants stated they regularly consumed only breakfast.

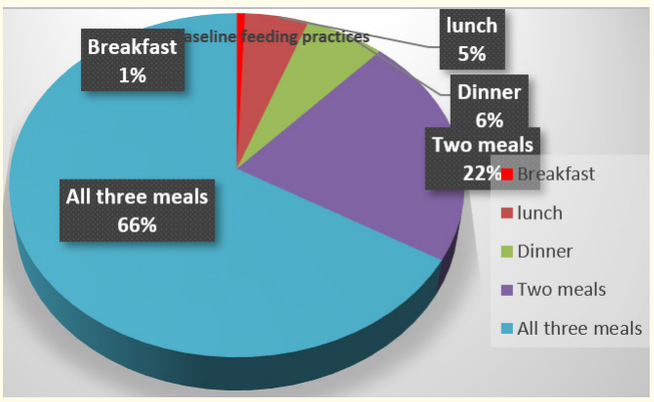

Figure 3: Baseline Meal Frequency of Subjects in the Study.

Figure 4 illustrates the midline meal frequency among the study participants. It shows that the proportion of volunteers consuming three regular meals daily increased to 85% from the baseline of 66%. Conversely, the percentage of those consuming two regular meals daily remained at 22%, showing no change from the baseline.

Furthermore, the percentage of participants who reported eating only lunch decreased to 3% from the baseline of 5%. Similarly, the proportion who reported having only dinner decreased to 1% from the baseline of 5%. None of the participants reported consuming only breakfast at midline.This shift in meal frequency highlights the impact of nutritional intervention on the feeding practices of TB patients in the study, indicating an improvement in regular meal consumption over time.

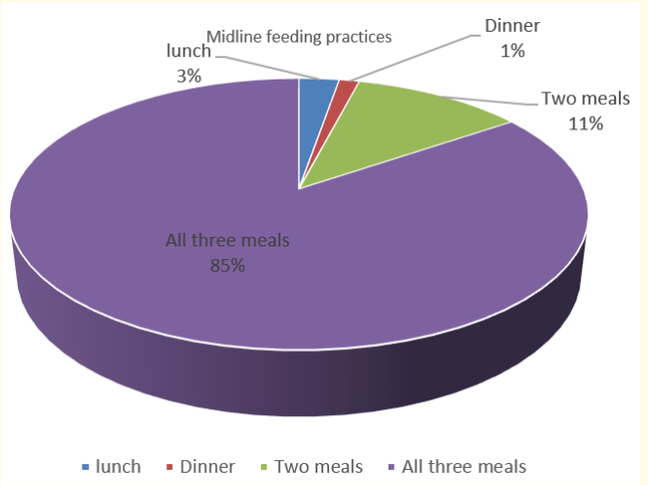

Figure 4: Midline Meal Frequency of Subjects in the Study.

Figure 5 presents the baseline feeding practices of study participants categorized by food class. It reveals that the majority of volunteers relied primarily on carbohydrate-rich foods, accounting for 40% of the sample. Nineteen percent of participants reported consuming meals that included both carbohydrates and protein-rich foods, while 18% had balanced meals incorporating all food classes regularly.

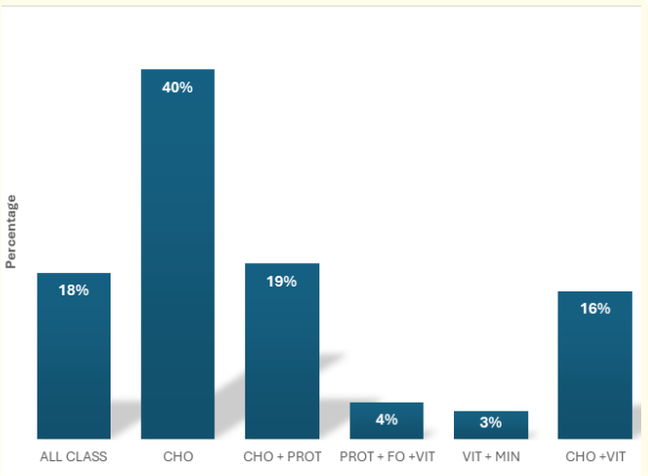

Figure 5: Baseline Feeding Practice of Subjects Based on Food Class.

Additionally, 16% of participants consumed meals consisting only of carbohydrates and minerals on a regular basis. The intake of micronutrients appeared low, with only 4% of volunteers reporting meals that included protein, fats, and oils, and a mere 3% indicating that their regular meals were predominantly rich in vitamins and minerals.

These findings underscore the nutritional challenges faced by TB patients at baseline, emphasizing the need for targeted dietary interventions to improve overall nutrient intake and support treatment outcomes.

Figure 6 illustrates the midline feeding practices categorized by food class among the study participants. It demonstrates notable improvements in dietary diversity compared to baseline findings. Specifically, the percentage of volunteers consuming meals that included all classes of food increased to 31%. Meanwhile, those relying solely on carbohydrate-rich foods decreased to 10%. Among other categories, 23% of participants reported consuming meals containing both carbohydrates and protein, while 26% indicated their meals included carbohydrates and vitamins. This diversification in food intake suggests a positive shift towards more balanced nutrition among the study group.

Furthermore, there was an improvement in micronutrient intake: 8% of volunteers reported meals that included protein, fats, and oils along with vitamins, indicating an uptake in essential nutrients. A smaller proportion, 2%, reported regular meals predominantly rich in minerals and vitamins only. These findings highlight the effectiveness of nutritional interventions in enhancing dietary practices among TB patients, potentially contributing to improved health outcomes and treatment adherence.

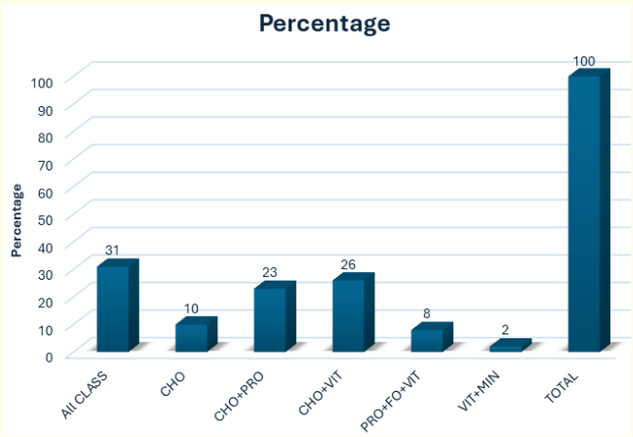

Figure 6: Midline Feeding Practices of Subjects Based on Food Class.

The anthropometric indices reflecting the baseline and midline nutritional status of the study volunteers are presented in Tables 4 and 5. At baseline (Table 4), Group A (HIV positive) exhibited no statistically significant difference in mean weight (62.8 ± 8.6) compared to midline (64.3 ± 9.5). However, Group A (HIV negative) showed a significant increase from baseline (56.8 ± 10.2) to midline (58.7 ± 11.0); t (2) = 2.30, p = 0.03.

In Group B, both HIV positive and negative subjects experienced an increase in mean weight from baseline to midline: HIV positive (60.8 ± 19.4 to 64.0 ± 17.9) and HIV negative (53.6 ± 10.0 to 56.2 ± 8.9). Similarly, Group C participants showed an increase: HIV positive (58.4 ± 8.2 to 58.1 ± 8.8) and HIV negative (58.4 ± 8.2 to 61.0 ± 8.1). Statistically significant differences in mean weight were observed in Group B and C between baseline and midline, regardless of HIV status.

For Group D, no statistically significant difference was found in mean weights between baseline and midline, irrespective of HIV status: HIV positive (57.8 ± 7.5 to 56.7 ± 7.1) and HIV negative (56.8 ± 9.1 to 56.3 ± 8.8). Underweight, indicative of undernutrition, was prevalent across all groups, particularly notable at baseline. These findings underscore the ongoing nutritional challenges among TB patients and emphasize the importance of continued intervention and monitoring to improve nutritional outcomes.

From table 5, Groups A, B, and C generally showed an increase in BMI from baseline to midline. Statistically significant increases ($p < 0.05$) were observed in Group A (HIV negative), Group B (HIV positive), Group B (HIV negative), and Group C (HIV positive). Group D showed no statistically significant change in BMI between baseline and midline. Despite increases observed, most groups had not yet achieved the ideal BMI for adults, indicating persistent undernutrition. These findings highlight the impact of nutritional interventions on improving BMI among TB patients, underscoring the ongoing need for effective nutritional support strategies in TB management programs.

Group (Intervention)	HIV Status		Baseline Weight (kg)	Midline Weight (kg)	t-test	p-value (< 0.05)
			Mean ± SD	Mean ± SD		
Group A (AN)	Positive	14	62.8 ± 8.6	64.3 ± 9.5	0.67	0.512
	Negative	26	56.8 ± 10.2	58.7 ± 11.0	2.30	0.030*
Group B (DF)	Positive	21	60.8 ± 19.4	64.0 ± 17.9	2.82	0.010*
	Negative	18	53.6 ± 10.0	56.2 ± 8.9	2.34	0.031*
Group C (SB)	Positive	10	54.7 ± 8.7	58.1 ± 8.8	2.64	0.027*
	Negative	28	58.4 ± 8.2	61.0 ± 8.1	2.06	0.049*
Group D (Control)	Positive	10	57.8 ± 7.5	56.7 ± 7.1	0.91	0.385
	Negative	22	56.8 ± 9.1	56.3 ± 8.8	0.29	0.778

Table 4: Weight of Subjects in the Study.

Reference value: Male (64.2kg), Female (57.4kg); Group A (AN = Antioxidant Neutriceutical), Group B (DF = Date fruits), Group C (SF = Soya beans flour) and Group D (C = Control with no intervention). n: 161; *p < 0.05 was considered statistically significant.

Discussion

Nutrition plays a crucial role in managing both acute and chronic diseases by influencing the body's immune response against pathogens like Mycobacterium tuberculosis (M.tb) [10]. Various nutrients, including macro- and micro-nutrients, have immunomodulatory effects that help control infection and inflammation. Malnutrition, in any form, can lead to nutritionally acquired immunodeficiency syndrome, significantly increasing susceptibility to TB progression from infection to disease.

While specific foods or quantities alone may not directly alter the course of TB or treat malnutrition, undernutrition remains a predominant risk factor for TB in resource-limited settings [11]. Recognizing this, the World Health Organization (WHO) recommends dietary supplementation and locally available nutrient-rich or fortified foods to restore normal nutritional status in TB patients [12,13].

Nigeria, with its rich diversity of food plants, has the potential to combat malnutrition and possibly aid in treating diseases if these resources are effectively utilized. Clinical trials and studies are essential to better understand the link between malnutrition, tuberculosis, and impaired immunity. These studies can help identify scientifically proven functional foods that provide essential nutrients needed by TB patients, potentially improving treatment outcomes and overall health.

The incidence and prevalence of tuberculosis (TB) highlight significant gender disparities and socioeconomic factors. In our study of 161 TB patients, 69.9% were males and 30.4% were females, reflecting global trends where TB affects more men than women, especially in low- and middle-income countries (14;15). Despite higher TB prevalence among men, global health efforts often emphasize women, overlooking men's health needs [16]. The World Health Organization's End TB Strategy underscores the need for equitable access to diagnosis and treatment, urging focused attention on high-risk groups like men [17].

Most TB cases in our study (80%) occurred among individuals aged 18-44 years, impacting the economically productive age group [18]. Education levels were significant, influencing health-seeking behaviours and treatment outcomes, with a majority of patients (65.2%) employed and a notable proportion (23.6%) not responding regarding occupation [19]. Socioeconomic status also played a role, with TB predominantly affecting the middle and lower classes, including those with low incomes and high unemployment rates [20].

Behavioural factors such as smoking and alcohol use were prevalent among TB patients, adversely affecting treatment adherence and outcomes [21,22]. Additionally, HIV co-infection was notable (36.6% of patients), significantly increasing the risk of developing active TB due to immunosuppression [23,24]. Addressing these multifaceted factors is crucial for improving TB control strategies and achieving equitable health outcomes across populations.

This study highlighted that approximately 50% of TB patients did not meet their recommended daily calorie intake. The nutritional needs of TB patients encompass energy requirements, macronutrients (carbohydrates, protein, fats), and micronutrients (vitamins, minerals, trace elements). Initially, 66% of patients reported consuming three meals daily, increasing to 85% by midline, likely influenced by nutrition education and improved appetites due to interventions rich in micronutrients, enhancing food palatability. Research underscores that meal timing and frequency impact weight management, with eating more than three meals daily and making supper the largest meal associated with higher BMI [25,26].

Regarding food group diversity, only 18% of patients had meals containing all six food groups at baseline, which improved to 31% by midline, likely correlating with the enhanced meal frequency observed. However, a significant concern was the inadequate consumption of micronutrient-rich foods. Emphasizing balanced diets is critical as they bolster immunity, protect against diseases, and contribute to achieving and maintaining healthy weight [27].

Body Mass Index (BMI) serves as a reliable indicator of nutritional status and has been associated with tuberculosis (TB) incidence across various settings. Studies have shown an inverse log-linear relationship between BMI and TB rates, with a 14% reduction in TB incidence per unit increase in BMI [28]. This study highlights significant malnutrition among TB patients, evident from their lower mean weight and BMI values at baseline. Weight loss and nutritional depletion are common at TB diagnosis [29], and many patients struggle to regain normal body weight during treatment.

Research indicates that supplementation can improve physical function and facilitate quicker recovery in TB patients, crucial for those reliant on physical strength for work [30]. This benefit is particularly relevant in resource-constrained settings where TB predominantly affects economically disadvantaged individuals. Improvements in quality of life, including social functioning and emotional well-being, were noted among patients receiving food supplements compared to controls.

The biological link between BMI and TB risk involves the modulation of cytokines within the immune system. A lower BMI is associated with decreased levels of pro-inflammatory cytokines (such

as IFN-γ, TNF-α, IL-22, IL-1α, IL-1β, IL-6) and increased levels of regulatory cytokines (IL-10, TGF-β, IL-5, IL-13) [31].

Conversely, higher BMI levels correlate with elevated pro-inflammatory cytokines and reduced anti-inflammatory cytokines [32]. This cytokine profile suggests that maintaining a higher BMI may protect against TB progression by promoting a more robust immune response.

Therefore, ensuring adequate BMI through nutritional support could potentially play a significant role in TB management. By enhancing immune function and improving treatment outcomes, maintaining optimal BMI levels might contribute positively to the overall management and recovery of TB patients.

Conclusion

Using indigenous functional food sources in ready-to-use forms represents a promising strategy for improving the recovery of tuberculosis (TB) patients. These foods are cost-effective and widely available in both rural and urban areas, making them accessible solutions for addressing nutritional deficits, especially in resource-limited settings like Nigeria. Their affordability ensures they can be seamlessly integrated into dietary interventions without imposing financial strains on patients or healthcare systems.

Moreover, indigenous foods have the potential to markedly enhance the nutritional status of TB-affected populations. Malnutrition is prevalent among TB patients and can impede their recovery and response to treatment. By supplying essential nutrients through locally available sources, healthcare providers can bolster immune function and physical recuperation, potentially expediting recovery timelines.

Additionally, incorporating indigenous functional foods supports sustainable nutrition practices and local food systems. This approach fosters economic activity within communities and enhances food security, fortifying resilience against economic downturns and disruptions in food supply chains.

In conclusion, integrating indigenous functional foods into TB management strategies offers a practical and effective means to mitigate the high incidence of TB in underdeveloped and developing countries. Addressing nutritional deficiencies with locally sourced, affordable functional foods can improve treatment outcomes and alleviate the overall burden of TB on affected populations. Future research and public health efforts should continue to explore and advocate for the utilization of indigenous functional food sources as integral components of comprehensive TB care and management protocols.

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