Applying Psychological and Educational Health Models to Determine the Effect of a Pharmacist-led Cognitive and Behavioral Intervention on Tuberculosis Treatment Outcomes in Plateau State, Nigeria

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Abstract

Background: The prolonged multi-drug treatment regimen for tuberculosis (TB) can lead to non-adherence and unsuccessful treatment outcomes. *Educational and psychological health models can be used to design cognitive and behavioral interventions to improve adherence and treatment outcomes.*

Objective: *To determine the effect of cognitive and behavioral interventions on TB treatment outcomes.*

Methods: *The quasi-experimental study conducted in six TB treatment centers involved reinforced medication education and adherence counseling (MEAC), designed from a structured validated psychometric scale. Data were collected three different times during the intensive and continuation phases of treatment from 463 TB patients (232 in the control and 231 in the intervention group). Baseline demographic and clinical characteristics were compared between the groups. The generalized estimating equation model was used to analyze the repeated measures by determining if treatment success was associated with the cognitive and behavioral interventions and medication adherence.*

Results: *The males made up 290(62.6 %) of the population. The mean age was 36.75±13.9. Most of the TB patients were newly diagnosed 413(89.2%) and HIV negative 315(68%), with secondary level of education 216(46.6%). There was no significant difference in baseline characteristics between the groups. The intervention group was four times more likely to have treatment success (p<0.01; CI=1.5-8.4), compared to the control group. Medication-adherent TB patients were 24 times more likely to have treatment success than patients who did not adhere (p<0.001; 10.8-52.1). TB patients' emotions, attitudes, and perceptions of their medicines were predictors of treatment success (p<0.05; 1.0 – 1.1).*

Conclusion: *The cognitive and behavioral interventions administered to TB patients improved successful treatment outcomes.*

Keywords: Cognitive-Behavioral Interventions, Psychological and educational health models, Tuberculosis treatment outcomes, Generalized Estimating Equation, Nigeria

Introduction

Tuberculosis is a major global health problem, being the 13th leading cause of death worldwide, and the 2nd leading cause of death from a single infectious agent after COVID-19.[1] *Mycobacterium Tuberculosis,* the causative agent for TB is an intracellular microorganism that replicates very slowly, therefore, a prolonged multi-drug treatment regimen of six months to one year is the recommended treatment strategy, implemented through Directly Observed Therapy (DOT).[2] Though treatment success is possible, challenges of medication adherence occur as a result of the prolonged multi-drug regimen.[3] Adherence is a complex and dynamic behavioral phenomenon that influences treatment outcomes.[4,5] Treatment outcomes classified as successful and unsuccessful are the major indicators for evaluating TB treatment programs.[6] Non-adherence is a major challenge to global TB control because it increases the risk of treatment failure, relapse, and the emergence of drug-resistant TB which are unsuccessful treatment outcomes.[7,8] Educational interventions have been shown to decrease non-adherence and improve successful treatment outcomes.[9-13]

Patient education can be structured using Bloom's taxonomy of learning objectives, which guides the transfer of knowledge and provides a basis for evaluation, including the extent to which such learning has occurred. Bloom's taxonomy classifies learning into cognitive, affective, and psychomotor domains.[14] In the cognitive domain, the pharmacist communicates to the patient information about his/her disease and medicines in a manner that will be easily understood. A high knowledge level of the TB's cause, its signs, symptoms, the possibility of transmission, prevention, and treatment/cure was found to be associated with a higher likelihood of achieving successful treatment outcomes compared to a low knowledge.[15] The affective domain focuses on emotion which draws attention and channels strong residual memory, thus affecting cognition.[16]

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DOI: https://doi.org/10.24926/iip.v13i4.5031

The psychomotor domain involves actions that patients can take to improve their health outcomes such as graded exercise and taking medicines correctly (adherence).[17]

Medication non-adherence can occur due to psychological and behavioral reasons consequently, psychological health research seeks to ascertain patients' understanding of their disease and how that understanding influences decisions taken in health and illness. Psychological and educational health interventions use theoretical models to explain health behaviors.[18,19] The Information-Motivation-Behavioral skills model (IMB) (Figure 1) is a psychological health model used to study adherence as a complex behavioral phenomenon. It proposes that information (cognition) is a prerequisite for changing behavior but in itself is not enough to produce this change. Motivation (affective) and behavioral skills (psychomotor) are the major determinants and are independent of behavioral change. Behavior can therefore be affected or driven by motivation through emotions. Information and motivation work largely on behavioral skills to affect behavior through informed decisions. Therefore, both information and motivation increase the likelihood of adherence.[20] The IMB model was applied in the development of the structured intervention tool used for Medication Education and Adherence Counseling (MEAC); the intervention administered to tuberculosis patients.[6] The relationship between the IMB model and tuberculosis treatment outcomes is explained in the conceptual model in Figure 2 where the IMB model equips the patient with the necessary skill for informed decisions to take his/her medicines correctly (adherence). The medicines are then absorbed and distributed to systemic circulation where their concentration can be measured and translated to adherence measurement. The medicines bind to their specific receptors leading to successful (therapeutic or desired) or unsuccessful (undesired or toxic) treatment outcomes.[21]

It was observed that most intervention studies targeted only adherence and improving adherence would be more valuable if it improves clinical/treatment outcomes of the patient.[3] The aim of this study therefore, was to determine the effect of cognitive and behavioral interventions on tuberculosis medication adherence and treatment outcomes in Plateau State, Nigeria.

Methods

Study Design and Setting

The quasi-experimental study was carried out in six tuberculosis Directly Observed Treatment (DOT) Centers in Plateau State. The centers included four faith-based institutions: Bingham University Teaching Hospital (BUTH) Jos; COCIN Hospital and Rehabilitation Center (CHRC) Mangu; Faith Alive Hospital (FAF) Jos; and Our lady of Apostles (OLA) hospital Jos. Others were Plateau State Specialist Hospital (PSSH) Jos, a tertiary health institution owned by the State Government; and Tudun Wada primary health clinic. The DOT centers were purposefully chosen based on preliminary information that they account for more than 50% of the reported and documented TB cases in Plateau State, Nigeria.

Population and Sample

Confirmed TB patients, aged 15 and above, made up the study population. The minimum sample size with an 80% chance of detecting significance and increasing treatment success from 64.4% (from a preliminary study)[8] to 80% was 270. An attrition rate of 40% was added to give 378 (189 in each arm of control and intervention groups). This was calculated using OpenEpi online calculator[22] shown in Table 1.

Ethics

The Institutional Health Research Ethics Committee of the Jos University Teaching Hospital, Jos, Nigeria, with reference number: JUTH/DCS/ADM/127/XIX/6442 approved the protocol for this study and access to the data used for the research. De-identified patient data was used for analysis. After careful explanation of the intent of the research, informed written consent was obtained from the patients before data collection.

Data Collection

The TB patients who had commenced drug treatment in the intensive phase irrespective of their category were the control group while newly diagnosed TB patients about to start drug treatment were the intervention group. Data collected using a structured validated intervention tool included: Patient demographic and clinical characteristics, knowledge of TB disease, perception of TB disease and anti-TB medicines, perceived sensitivity to medicines, emotional status, and medication adherence.[6] Data were collected at the intensive (month 1), beginning (month 3), and end (month 6) of continuation phases of treatment. Baseline demographic and clinical characteristics were compared between the groups. Five hundred copies of the 42-item questionnaire (Table 8) were administered (250 copies for each group). Data were collected from June 2016 to September 2017 by trained research assistants who were DOT officers in the centers and recent pharmacy graduates awaiting internship placements.

Data Analysis

Categorical variables were described by frequencies and proportions. Baseline demographic and clinical characteristics were matched using the Chi-square test to determine any significant difference between the control and intervention groups. To assess TB knowledge, a score of "1" was assigned for every correct response, while a score of "0" was assigned to an incorrect response. Knowledge of TB was expressed as a percentage of correct responses of the total score. The mean knowledge score was compared between the control and intervention groups using the independent sample's test (t-test). An index score was created using a Likert scale of 1 (strongly disagree) to 5 (strongly agree) for the intervention domains [patients' knowledge of TB disease, their perception of

DOI: https://doi.org/10.24926/iip.v13i4.5031

TB disease and anti-TB medicines, their perceived sensitivity to medicines (cognitive), their emotional status, and medication adherence (behavioral)].[6]

A model was built in which the cognitive and behavioral scores were measured at the intensive (month 1), beginning (month 3), and end (month 6) of the continuation phases of data collection. The generalized estimating equation (GEE), a repeated measure regression analysis was used to test if the cognitive and behavioral interventions were significant predictors of treatment success, and whether the different intervention domains were independently related to treatment success. Designs used in intervention studies that have multiple follow-up points typically involve repeated measurement of participants' responses. Therefore, correlation within each participant is expected. The GEE, an extension of the Generalized Linear Model (GLM) method specifies how the average of a response variable of a subject changes with covariates while allowing for the correlation between repeated measurements on the same subject over time. Therefore, correct inferences can only be obtained by taking into account this within-participant correlation between repeated measurements.[23,24] Statistical significance was set at $p < 0.05$.

Cognitive and Behavioral Interventions: Medication Education and Adherence Counseling (MEAC)

All the patients received standard routine therapy from the health workers during their clinic appointments which involved precautions to take when sneezing and coughing, the need to take their medicines daily (at least an hour before breakfast), and an understanding of the reason for the long duration of treatment. Additionally, the intervention group received reinforced medication education and adherence counseling (MEAC), a designed structured educational program administered by trained research assistants. The intervention domains included the respondent's knowledge of TB disease, their perception of TB disease and anti-TB medicines, their perceived sensitivity to medicines (cognitive), their emotional status (behavioral), and medication adherence (Table 8).

After baseline data collection using the Likert scale, the patients in the intervention group were educated on the domains they received low scores. These low scores indicate negative perceptions of TB disease and/or the anti-TB medicines they were taking. The same data were collected at the intensive phase and continuation phases of treatment. The same psychometric scale was administered to the control group but without counseling or education during the study period. The treatment outcomes for both groups were measured at the same time and analyzed.

Outcome Measures

The outcomes measures were the standard tuberculosis treatment outcomes defined by the Federal Ministry of Health in Nigeria.[2] They are also nationally accepted indicators for monitoring TB management.[8] The outcome measures were obtained from the TB patient's treatment cards upon completion of treatment. They include:

1. Successful treatment outcomes, made of cured and completed treatment which should increase towards 100% and reach at least 85% with good case management.[25]
   a. **Cured** refers to a pulmonary TB patient who was smear or culture positive at the beginning of treatment and is smear or culture negative upon completion of treatment.[2]
   b. **Completed Treatment** is a TB patient who completed treatment but without evidence (no laboratory test) at the end of treatment.[2]
2. Unsuccessful treatment outcomes in this study include: not evaluated, lost-to-follow-up/default, treatment failure, and death.[25]
   a. **Not evaluated** is a TB patient for whom no treatment outcome is assigned. This includes 'transfer out' cases where the treatment outcome there is unknown to the reporting unit.[2]
   b. **Lost to follow-up** is a TB patient who did not start treatment or whose treatment was interrupted for two consecutive months or more.[26]
   c. **Default** is defined as missing more than 20% of the prescribed doses during the treatment period. The definition of defaulters can vary within national programs.[20] The Federal Ministry of Health in Nigeria defined defaulting as not taking anti-TB medications consecutively for more than two days intensive phase and more than two consecutive weeks continuation phase.[25]
   d. Treatment Failure is a PTB patient who was smear or culture positive at beginning of treatment and remains positive at month five or later during their most recent course of treatment.[2]
   e. **Relapse** is a Pulmonary Tuberculosis (PTB) patient who was cured or completed treatment but returned sputum positive or with clinical symptoms of TB (either a true relapse or a new episode of TB caused by reinfection).[2]
   f. **Died** refers to a TB patient who died for any reason during TB treatment.[2]

The outcome measures were collected from the TB patient's treatment card upon completion of treatment.

Results

Demographic and Clinical Characteristics

Out of the 500 questionnaires distributed, 463 (232 control and 231 intervention) were correctly filled, giving a 92.6% response rate. The males made up 290(62.6 %) of the population. The mean age ± standard deviation of the TB patients was 36.75 ± 13.9. Most of the patients had a secondary level of education 216(46.6%) and resided in Jos North Local Government Area of Plateau State. About 68% of the patients were HIV-negative and

DOI: https://doi.org/10.24926/iip.v13i4.5031

were newly diagnosed with TB 413(89.2%). The baseline comparison between the control and intervention groups in terms of demographic and clinical characteristics showed no significant difference (Tables 2 and 3).

Cognitive Intervention

At baseline, there was no significant difference in the percentage of patients who gave correct responses (Table 4). The total mean knowledge score was however significantly (p<0.001) higher in the intervention than the control group, with a mean difference of 1.532 (Table 5).

Tuberculosis Treatment Outcomes

The intervention group had a higher adherence level (91.3%) than the control group (89.7%), but the difference was not significant. The intervention group however had a higher significant successful treatment outcome rate of 93.5% than the control group (81.5%) (Table 3). Holding all the other factors constant, the intervention group was almost four times more likely to have successful treatment outcomes than the control group from the binary logistic regression analysis (Table 6).

The generalized estimating equation of factors associated with tuberculosis treatment outcomes in Table 7 showed that compared to the controls, the intervention group also had almost four times greater likelihood of treatment success. The likelihood of treatment success increased to about 24 times in patients adherent to their TB medication compared to non-adherent patients. Additionally, treatment success was significantly associated with the patient's emotional status and belief about TB medicines. The likelihood of treatment success increased by about 2% and 5% for every unit increase in the emotional status and perception of TB medicines respectively.

Discussion

This study determined the effect of cognitive and behavioral interventions on TB treatment outcomes. TB disease was found more in males than females as observed in a previous baseline retrospective study[8] and the TB global report.[1] This could be due to the tendency of men to indulge in more risky behaviors (alcoholism and cigarette smoking) than women, thus making them more at risk.[27,28] TB disease was found most in the productive/working age group of 35-44 years as also reported in a previous study[8] and other studies consistent with global epidemiological findings.[29-32]

Comparison Between Control and Intervention Groups

The TB patients were matched by comparing their baseline characteristics to ensure that there was no bias during patient recruitment. The implication for no statistical significance in the baseline demographic and clinical characteristics between the control and intervention groups suggested that the groups were comparable and could be said to be similar as similarly observed in a study.[12]

Cognitive Intervention

The percentage of patients with correct responses to the knowledge questions was significantly higher in the intervention group than in the control group except for the question on alcohol and cigarette smoking. This could be due to the data being crude and without adjustments for possible confounders at baseline. However, the significantly higher mean difference in total knowledge score in the intervention group compared to the control group implied a positive effect of the cognitive intervention on knowledge as seen in Table 5. Several studies reported the positive effect of similar interventions on patient cognition administered through patient education and adherence counseling, to achieve positive behavioral change such as medication adherence. This increases the likelihood of treatment success, as modeled by the WHO's Information-Motivation-Behavioural skills model applied in this study.[6,11-13,33]

The more knowledgeable TB patients are about their disease, the more likely they will complete their treatment and be cured of TB disease (treatment success).[15,33] Low knowledge level is associated with poor treatment outcomes, as a higher educational level is perceived to reduce ignorance and increase knowledge on drug management and consequences. TB patients should therefore be educated on TB disease, preventive measures, diagnostic procedures, treatment modalities, and possible adverse drug events in the language they best understand to increase their knowledge of TB disease and management. Consequently, the likelihood of adherence and treatment outcomes will increase.

Factors Associated with Tuberculosis Treatment Outcomes

The slight improvement in medication adherence in the intervention than the control group shown in Table 3 may have contributed to successful treatment outcomes though the difference was not significant. The GEE analysis from this study showed that the intervention group had almost four times greater likelihood of treatment success compared to the control group, with the likelihood of treatment success increasing to about 24 times in patients adherent to their TB medication compared to non-adherent patients. This correlates with an observation from previous studies that adherence influences treatment outcomes.[4,5,34] Similar intervention studies were designed based on health theories/models to ensure the development of coherent interventions, enable more careful assessment of the intervention's impact, explain better ways to achieve positive behavior change, and evaluate the intervention better.[13,19,35-37]

From the GEE, the significant association between patients' emotional status and belief about their TB medicines and treatment success suggests that deliberately encouraging the patients to have a positive attitude towards their treatment, specifically believing that TB is curable when they adhere to taking their medications, will likely improve successful

DOI: https://doi.org/10.24926/iip.v13i4.5031

treatment outcomes. In other words, when patients are motivated to take their medicines as a result of positive emotions developed from counseling and/or education, they are likely to respond with improved behavior such as taking their medicines correctly (adherence) which will likely lead to the cure (successful outcome) of their TB disease. Cognitive and behavioral interventions therefore enable the patient who is at the center of therapy to make informed decisions and be an active participant in his/her disease management. The patient usually is free to decide whether to take the treatment or not. However, the healthcare practitioner has a responsibility to help ensure that the choice the patient makes is an informed one. Therefore, once patients are diagnosed with TB, their cognitive and emotional status should be assessed and appropriate interventions should be administered to achieve successful treatment outcomes. This study was limited by the non-random allocation of patients into the control and intervention groups. However, there was no significant difference of baseline demographic and clinical characterisitcs between the groups when they were matched. The effect of the interventions on treatment outcomes of patients with other chronic illness can also be assessed.

Conclusion

The cognitive and behavioral interventions administered to TB patients significantly improved successful treatment outcomes. TB patients that adhered to taking their anti-TB medicines also had significantly improved treatment outcomes. Therefore, once patients are diagnosed with tuberculosis, medication education and adherence counseling (MEAC) should be administered periodically during therapy to improve treatment outcomes.

List of Abbreviations:

TB: Tuberculosis
MDR-TB: Multidrug Resistant-Tuberculosis
AFB: Acid Fast Bacilli
NTBLCP; National Tuberculosis and Leprosy Control Program
WHO: World Health Organization
DOT: Directly Observed Therapy
OLA: Our Lady of Apostles Hospital
FAF: Faith Alive Foundation Hospital
CHRC: COCIN Hospital and Rehabilitation Centre Mangu
BUTH: Bingham University Teaching Hospital
PSSH: Plateau State Specialist Hospital

Competing interests: We declare no conflicts of interest or financial interests that the authors or members of their immediate families have in any product or service discussed in the manuscript, including grants (pending or received), employment, gifts, stock holdings or options, honoraria, consultancies, expert testimony, patents, and royalties.

Funding: This research was supported by the Africa Centre of Excellence in Phytomedicine Research and Development (ACEPRD) with grant award number 126974.

Authors' Contributions: CS conceptualized the research idea and designed the study, CS and MD analyzed the data. MD, NL, JK, and JA read and revised the manuscript. CS wrote the first draft of the manuscript and all co-authors read and approved the final version.

Acknowledgements: The authors are grateful to the DOT officers in the study sites, Pharmacist Joshua Dung, Pharmacist Joel Bulus, and Pharmacist Samson Chuwang for their support during data collection. The contribution of Pharm. Isaac Abah in data analysis is acknowledged.

The opinions expressed in this paper are those of the authors.

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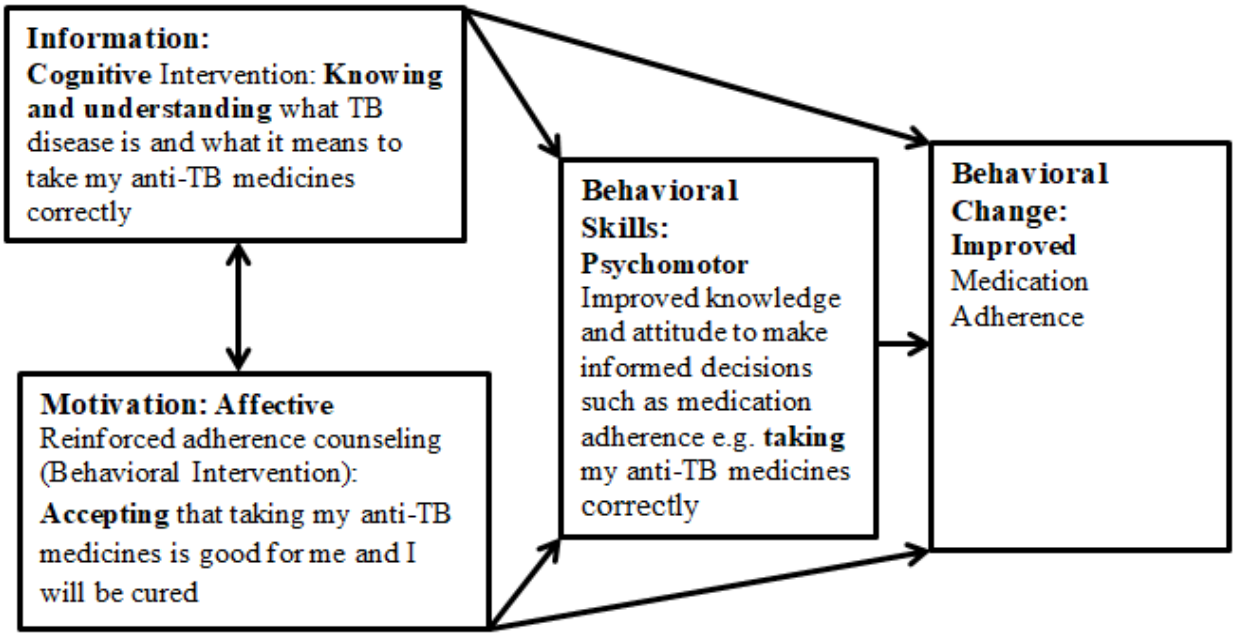

Figure 1: Information-Motivation-Behavioral Skills Model[6,20]

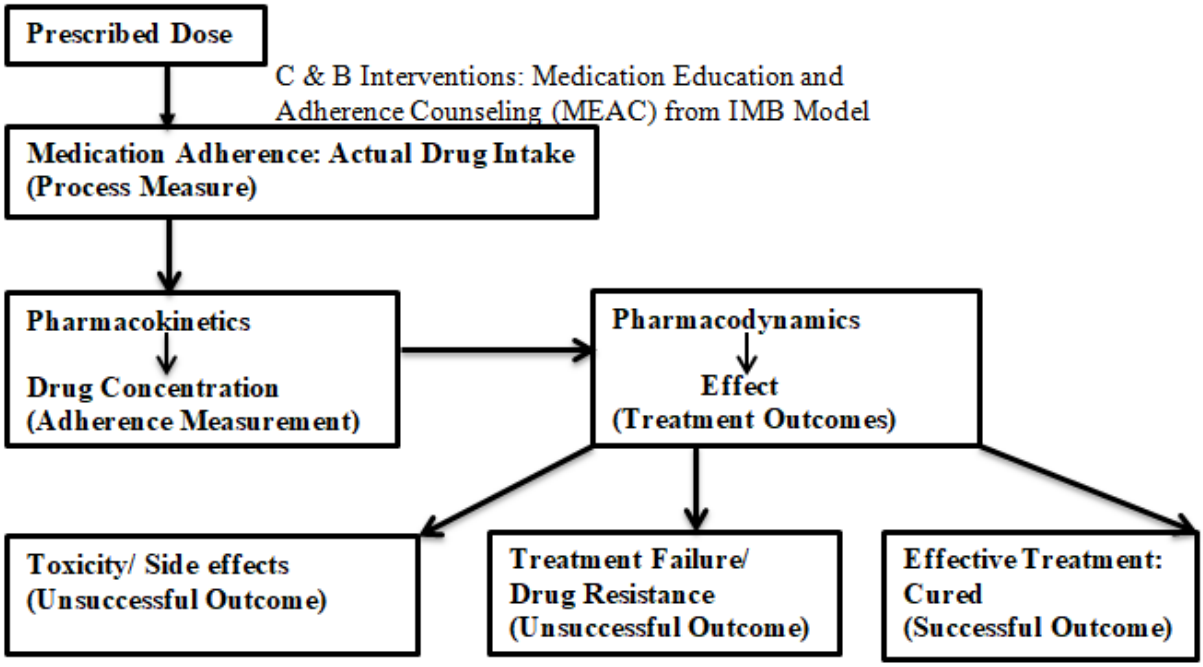

Figure 2: Conceptual Model relating cognitive and behavioral Interventions, Medication Adherence and Treatment Outcomes[5]
C & B = Cognitive and Behavioral; IMB = Information-Motivation-Behavioral Skills

DOI: https://doi.org/10.24926/iip.v13i4.5031

Table 1: Sample Size Determination

Sample Size: Cross-Sectional, Cohort, & Randomized Clinical Trials[22]	
Two-sided significance level (1-alpha)	95
Power (1-beta, % chance of detecting)	80
Ratio of sample size, Unexposed/Exposed	1
Percent of Unexposed with Outcome	64
Percent of Exposed with Outcome	80
Sample Size – Exposed	135
Sample Size – Non-exposed	135
Total sample size:	270

Sample size = 270 + (40% of 270 for attrition) = 378

Table 2: Demographic Characteristics of Tuberculosis Patients (n=463)

	Variable	Control (n=232)	Intervention (n=231)	Total	(χ) *p*
Gender	Male	144	146	290	(0.06) 0.80
	Female	88	85	173	
Age Group	15-24	42	40	82	(6.71) 0.15
	25-34	61	75	136	
	35-44	70	59	129	
	45-54	26	36	62	
	> 54	33	21	54	
Educational Status	None	34	23	57	(5.23) 0.16
	Primary	53	41	94	
	Secondary	101	115	216	
	Tertiary	44	52	96	
Occupation	Business	103	72	175	(9.34) 0.10
	Employed	48	61	109	
	Housewife	29	36	65	
	Applicant	17	24	41	
	Student	30	31	61	
	Others	5	7	12	
Monthly Income (naira)	None	77	91	168	(2.04) 0.37
	< 18,000	80	75	155	
	≤18,000	75	65	140	
Marital Status	Single	96	97	193	(0.54) 0.91
	Married	117	119	236	
	Divorced	7	5	12	
	Widow(er)	12	10	22	
Area of Residence	Jos North	144	155	299	(1.57) 0.81
	Jos South	25	22	47	
	Jos East	10	10	20	
	Other LGs in PL	46	37	83	
	Other States*	7	7	14	
Religion	Christianity	164	174	338	(2.58) 0.24
	Islam	66	57	123	
	Traditionalist	2	0	2	

*χ=Chi Square, LGs=Local Governments, PL=Plateau, *=Other states outside Plateau, TALF=Treatment after loss to follow-up*

DOI: https://doi.org/10.24926/iip.v13i4.5031

Table 3: Clinical Characteristics of Tuberculosis Patients n=463

	Variable	Control (n=232)	Intervention (n=231)	Total	(χ^2) *p*
HIV Status	Negative	165	150	315	(2.06) 0.29
	Positive	67	81	148	
Patient Category	*New	208	205	413	(0.62) 0.72
	TALF	6	9	15	
	Relapse	18	17	35	
Alcohol Intake	Yes	78	58	136	(4.04) 0.04
	No	154	173	327	
Cigarette Smoking	Yes	37	36	73	(0.01) 0.91
	No	195	195	390	
Co-morbidity	Yes	79	95	174	(2.47) 0.12
	No	153	136	289	
Adherence	Adherent	208	211	419	(0.38) 0.54
	Non-adherent	24	20	44	
Treatment Outcome	Successful	189	216	405	(15.315)**<0.001**
	Unsuccessful	43	15	58	

*χ=Chi Square analysis, TALF=Treatment After Lost to Follow-up, *New=Patients diagnosed with TB and accessing treatment for the first time.*

DOI: https://doi.org/10.24926/iip.v13i4.5031

Table 4: Comparison of Knowledge between control and intervention groups (n=463)

Assessment question	Number (%) of participants with correct response			Chi-square (*p* value) a vs b
	Control[a]	Intervention[b]	All patients	
A. At Baseline				
1. Cause of TB disease	53 (22.94)	45 (19.4)	98 (21.17)	0.87 (0.350)
2. Main mode of spread of TB	154 (66.67)	154 (66.38)	308 (66.52)	0.004 (0.950)
3. Does TB disease run in the family?	120 (51.95)	114 (49.14)	234 (50.54)	0.36 (0.550)
4. Can the type of food you eat worsen or improve TB?	93 (40.26)	72 (31.03)	165 (35.64)	4.29 (0.040)
5. Alcohol worsens TB	209 (90.48)	226 (97.41)	435 (93.95)	9.81 **(0.002)**
6. Smoking worsens TB	212 (91.77)	227 (97.84)	439 (94.82)	8.68 **(0.003)**
B. Post-Intervention				
1. Cause of TB disease	55 (23.81)	180 (77.59)	235 (50.76)	133.92 **(<0.001)**
2. Main mode of transmission of TB	155 (67.10)	189 (81.47)	344 (74.30)	12.51 **(<0.001)**
3. Does TB disease run in the family?	119 (51.52)	218 (93.97)	337 (72.79)	105.30 **(<0.001)**
4. Can the type of food you eat worsen or improve TB?	93 (40.26)	186 (80.17)	279 (60.26)	77.00 **(<0.001)**
5. Alcohol worsens TB	228 (98.70)	231 (99.57)	459 (99.14)	1.02 (0.310)
6. Smoking worsens TB	228 (98.70)	232 (100.00)	460 (99.35)	3.03 (0.080)

Table 5: Independent Samples Test of mean knowledge score between control and intervention groups (n=463)

	Mean Difference	T	Df	*p*	95 % CI	
					Lower	Upper
K pre- intervention	-0.05	-0.41	461	0.680	-0.29	0.19
K post- intervention	1.53	12.90	461	**0.000**	1.29	1.76

K= Mean Knowledge Score; CI= Confidence Interval

DOI: https://doi.org/10.24926/iip.v13i4.5031

Table 6: Binary Logistic Regression of Factors Associated with Tuberculosis Treatment Outcomes (n=463)

Variable	Sub-Category	df	*P*	Odds Ratio	95% C.I. for OR	
					Lower	Upper
Patient Group	Control*					
	Intervention	1	**0.000**	3.725	1.920	7.230
Sex	Female*					
	Male	1	0.287	1.530	0.700	3.344
Age Group	15-24*					
(Years)	25-34	1	0.398	0.634	0.220	1.827
	35-44	1	0.912	0.937	0.292	3.002
	45-54	1	0.969	1.028	0.258	4.092
	>54	1	0.195	0.388	0.093	1.623
Education	No formal*					
	Primary	1	0.888	0.915	0.268	3.127
	Secondary	1	0.683	0.783	0.242	2.534
	Tertiary	1	0.176	0.398	0.105	1.512
Occupation	Business*					
	Employed	1	0.192	0.554	0.228	1.345
	Housewife	1	0.550	0.438	0.029	6.553
	Applicant	1	0.147	0.136	0.009	2.021
	Student	1	0.240	0.201	0.014	2.917
Income	None*					
(Naira)	≤18,000	1	0.376	0.315	0.024	4.067
	>18,000	1	0.553	0.454	0.033	6.161
Patient Category	New*					
	TALF	1	0.472	2.218	0.253	19.453
	Relapse	1	0.719	0.823	0.286	2.370
HIV Status	Negative*					
	Positive	1	0.731	1.193	0.435	3.274
Alcohol	No*					
consumption history	Yes	1	0.178	0.589	0.273	1.273
Cigarette Smoking	No*					
	Yes	1	0.641	0.800	0.313	2.045
Disease Comorbidity	No*					
	Yes	1	0.266	0.577	0.219	1.521

**=Reference group; TALF=Treatment after lost to follow-up; CI= Confidence Interval; OR=Odds Ratio; p value*

Table 7: Generalized Estimating Equation of Factors Associated with Tuberculosis Treatment Outcomes (n=463)

Parameter	B	Hypothesis Test			Exp (B)	95% CI for Exp (B)	
	Slope	Chi-Square	df	*P*	OR	Lower	Upper
Intervention	1.265	8.337	1	**0.004**	3.540	1.501	8.360
Control	Ref				1		
Adherent	3.167	62.402	1	**<0.001**	23.730	10.820	52.050
Non - Adherent	Ref				1		
Knowledge	-0.011	2.642	1	0.104	0.990	0.975	1.002
TB Dx Perception	-0.009	0.482	1	0.488	0.990	0.968	1.016
Emotion	0.018	3.909	1	**0.048**	1.020	1.000	1.037
TBMedPercp	0.051	4.464	1	**0.035**	1.050	1.004	1.103
Sensitivity	-0.003	0.033	1	0.857	0.997	0.969	1.027

CI = Confidence Interval; Ref=Reference group; OR=Odds Ratio; Dx = Disease; TBMedPercp = Perception about TB medicines

DOI: https://doi.org/10.24926/iip.v13i4.5031

Structured Intervention Tool for Cognitive and Behavioral Intervention Scale
(Medication Education and Adherence Counseling-MEAC)

Please tick (√ or X) your response in the space provided to indicate the extent to which you agree or disagree with the statements below. There is no right or wrong answers, your personal views are most important.
Thank you.

A1. Respondent's knowledge of TB disease

1.	Tuberculosis (TB) is caused by { }Virus	{ } Bacteria	{ } Cigarette smoking	
		{ } I don't know	{ } Others_____	
2.	Tuberculosis can be spread mainly through	{ } Water	{ } Body contact	
	{ } Sharing things e.g. spoon, cup, towel	{ } Air	{ } Blood	{ } I don't know
3.	TB is curable	{ } Yes	{ }No	{ } I don't know
4.	Does TB disease run in the family?	{ } Yes	{ } No	{ } I don't know
5.	Can the type of food you eat affect TB disease?	{ } Yes	{ } No	{ } I don't know

DOI: https://doi.org/10.24926/iip.v13i4.5031

Table 8: Principal Component Analysis and Reliability of Cognitive and Behavioral Intervention Scale[6] (N=115)

	Item	Rotated Component Matrix Factor Loading Component						αs if item is removed
A2	**Respondent's knowledge of TB disease**	**1**	**2**	**3**	**4**	**5**	**6**	
	α = 0.805, Inter-item correlation: 0.455 - 0.841							
1	Alcohol can worsen TB	0.22	0.11	-0.26	0.16	0.05	**0.90**	0.645
2	Smoking can worsen TB	0.23	0.07	-0.23	0.16	0.07	**0.90**	0.623
3	*Pollution in the environment can worsen TB	0.31	-0.03	-0.21	0.07	0.04	**0.51**	0.913
B	**Perception of TB disease**							
	α = 0.586, Inter-item correlation: 0.081 - 0.406							
4	My illness (TB) will last a short time	0.12	0.10	**-0.84**	0.08	0.06	0.25	0.568
5	My illness will improve with time	0.23	-0.07	**-0.58**	-0.02	0.13	0.33	0.497
6	There is a lot which I can do to control my symptoms	0.23	-0.03	**0.52**	0.26	0.15	0.34	0.395
7	My illness is a serious condition	0.44	0.07	**0.52**	0.01	0.23	0.27	0.543
8	My illness strongly affects the way others see me	0.25	0.00	**0.51**	-0.09	0.01	-0.21	0.573
C	**Emotional status of respondent**							
	α = 0.888, Inter-item correlation: 0.533 - 0.799							
9	Having this illness makes me feel anxious	**0.90**	0.06	-0.05	0.01	0.20	0.22	0.847
10	My illness makes me feel afraid	**0.83**	-0.14	-0.03	-0.04	0.16	0.11	0.860
11	My illness makes me feel angry	**0.76**	0.12	-0.24	-0.07	0.28	0.37	0.861
12	My illness makes me have a negative attitude to life	**0.67**	0.09	-0.04	-0.05	0.23	0.16	0.868
13	My emotional state can affect my illness	**0.66**	0.03	-0.30	0.01	0.02	0.36	0.879
D	**Medication Adherence**							
	α = 0.878, Inter-item correlation: 0.542 - 0.726							
14	Do you ever forget to take your anti-TB medicines?	-0.16	0.10	0.09	**0.81**	-0.09	0.08	0.852
15	Are you careless at times about taking your medicines?	-0.00	0.06	0.12	**0.90**	0.04	0.12	0.821
16	When you feel better, do you sometimes stop taking your medicines?	0.11	-0.04	0.01	**0.86**	0.18	0.01	0.843
17	Sometimes if you feel worse when you take your anti-TB medicines, do you stop taking them?	0.02	-0.13	0.16	**0.81**	-0.07	0.16	0.846
E	**Perception of anti-TB medicines**							
	α = 0.650, Inter-item correlation: 0.138 - 0.642							
18	My medicines are effective in curing my illness	0.07	-0.15	-0.41	0.29	**0.76**	0.33	0.524
19	My medicines protect me from becoming worse	-0.13	-0.05	-0.36	0.34	**0.65**	0.26	0.514
20	My health in the future will depend on my medicines	0.14	-0.09	-0.21	0.04	**0.64**	0.32	0.546
21	My life will be impossible without my medicines	0.27	-0.00	-0.16	0.02	**0.50**	0.31	0.538
22	Natural remedies are safer than my TB medicines	0.19	0.21	-0.34	0.06	**0.63**	0.21	0.509
F	**Perceived Sensitivity to medicines**							
	α = 0.874, Inter-item correlation: 0.610 - 0.774							
23	I have had a bad reaction to medicines in the past	0.08	**0.79**	-0.19	0.01	0.26	0.01	0.868
24	My body overreacts to medicines	0.07	**0.88**	-0.03	-0.01	0.12	0.05	0.830
25	I usually have stronger reactions to medicines than most people	0.12	**0.89**	-0.05	-0.01	0.14	0.13	0.756

Note. Extraction Method-Principal Component Analysis, Rotation Method-Varimax with Kaiser Normalization. Additional knowledge items: cause of TB, its mode of transmission, whether TB was genetic or not, and effect of type of food eaten during TB therapy on treatment outcome were used for the cognitive intervention; α=Cronbach's alpha; Responses from A2 to F were measured on a 5-point Likert scale.

DOI: https://doi.org/10.24926/iip.v13i4.5031