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Health-related quality of life among adults newly diagnosed with pulmonary tuberculosis in Lagos State, Nigeria: a prospective study

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Abstract

Purpose Tuberculosis (TB) has far-reaching effects on the social, mental, and emotional well-being of patients and consequently, their health-related quality of life (HRQOL). Few studies in Nigeria have examined changes in quality of life over the course of treatment. changes in (PTB) and factors associated with HRQOL.

Methods A prospective cohort study was conducted with patients recruited from health facilities in Lagos State. The World Health Organization Quality of Life Instrument, Short-Form (WHOQOL-BREF) was used to assess HRQOL. A semi-structured questionnaire was also administered to elicit information on socio-demographic characteristics and the medical and social history of the respondents. Data were analysed using Statistical Package for the Social Sciences (SPSS) version 23. A repeated measures analysis of variance (ANOVA) test with polynomial contrasts was used to assess how domain scores varied over time. Multivariable analysis was conducted using generalized estimating equations (GEE) to assess change in HRQOL and its predictors.

Results Two hundred and ten patients, predominantly male [108 (63.3%)] were recruited. The mean age was 36.7 ± 12.3 years. The HRQOL was impaired in all four domains at baseline. However, HRQOL scores increased over the treatment period with the largest improvement being in the 'environment' domain, where mean scores increased from 45.27 ± 14.59 to 61.28 ± 15.86. The proportion of respondents that expressed satisfaction with their health increased from 13.5% at baseline to 55.7% at the end of treatment. Low socio-economic status, delay in presentation, and an HIV-positive status were found to be significantly associated with reduced HRQOL at baseline ($p < 0.05$). In the multivariable longitudinal analysis, patients who were employed had higher HRQOL scores while persistent symptoms and a delay in presentation (≥ 4 weeks) were negatively associated with change in HRQOL scores over the course of treatment.

Conclusion The HRQOL of respondents progressively improved over the six-month treatment period. However, change in HRQOL was influenced by a delay in presentation and persistence of symptoms. The study also highlights the need for increased recognition of patient-reported outcomes as an adjunct outcome measure.

Keywords Tuberculosis · Health-related quality of life · Outcomes · Patients · Nigeria · WHOQOL-BREF

Background

Tuberculosis (TB) is a chronic multi-systemic disease caused by *mycobacterium tuberculosis* and other species of the *mycobacterium tuberculosis complex* [1]. Tuberculosis is associated with significant morbidity and mortality [2]. In 2020, about 9.9 million new cases of TB were reported globally, with 1.3 million deaths including 400,000 deaths among people positive for the Human Immunodeficiency Virus (HIV) [1]. Nigeria is one of the eight countries responsible for two-thirds of the global burden of TB [1] and with 452,000 new cases in 2020, TB continues to be a

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major public health problem in Nigeria [3]. Recent studies suggest an annual risk of infection as high as 6.2% in the country [4]. Lagos State has the highest notification rates in Nigeria, with 8410 TB cases notified in 2014 and accounts for about 11% of the TB cases registered in Nigeria annually [5]. The State is characterized by an extremely high population density, rapid urbanization, and proliferation of urban slums. All these factors tend to favour overcrowding and poor housing, which are well-known risk factors for transmission of TB [6].

Quality of life is a vital measure in assessing population well-being and health status [7] and is becoming an important outcome by itself and a supplement to traditional biological outcomes [8]. The impact of a chronic illness like TB on an individual patient is often far-reaching, affecting not only their physical health but also psychological, economic, and social components of health [9]. All these dimensions have a great impact on the functional and overall wellbeing of the patient and can consequently impair the quality of life of the patient suffering from TB and consequently impact negatively on treatment outcomes [10].

Globally, a few longitudinal studies have measured quality of life of patients with TB [11–13]. Iti et al., studying TB patients in India found that HRQOL was impaired across the four domains at the beginning of treatment with the physical and psychological domain being the worst affected. By the end of a six-month treatment, domain scores increased significantly across all domains. [14]. In contrast, a study in East Taiwan, reported that the physical domain scores significantly decreased between onset of treatment and two-months and then increased at six months of treatment. A similar pattern was seen in the social, environmental, and psychological domain scores [15]. A prospective study in a South African setting assessed HRQOL using the Short Survey form -12 (SF-12) showed significant improvement in the physical and mental component summary scores following six months of treatment [16].

Tuberculosis control programmes still appear to focus on achieving successful treatment outcomes in terms of traditional clinical indicators such as achieving a microbiological cure or completing therapy [14]. In Nigeria, literature on HRQOL is limited but growing, and several of these studies on HRQOL have shown that patients with tuberculosis have deficits in physical, psychological, social, and environmental domains of HRQOL. However, majority were cross-sectional in design, and comprised patients at different phases of treatment [17–19]. Thus, it is difficult to draw conclusions about changes in HRQOL over the course of treatment, and if treatment has a positive effect, or otherwise, on HRQOL. Cross-sectional designs are also unable to investigate predictors that may influence changes in HRQOL. This could be better elucidated using a longitudinal design. To our knowledge only one other study was longitudinal in design, and this focussed on patients treated in a tertiary health facility setting/national research institute [20]. The objective of our study was to measure changes in the HRQOL in adult patients with TB over the course of directly observed treatment short-course (DOTS)-based treatment. We also assessed factors that were associated with HRQOL. With the findings from this study, it is envisaged that health care providers will have a broader picture of the functioning and well-being of TB patients at different phases of treatment, so that individual patient-specific needs are addressed. It is also envisaged that HRQOL could be considered as an adjunct outcome measure for TB patients treated through the TB-DOTS programme, thus contributing to a holistic approach to case management.

Materials and methods

Study setting

This study was conducted in Lagos State, located in Southwestern Nigeria and commonly described as the economic centre of the country [21].. It has a population growth rate of about 600,000 per annum and a population density of 2594 persons per square kilometre [22]. The state is made up of twenty local government areas (LGAs) which are then grouped into three (3) senatorial districts. The study was conducted in publicly owned TB-DOTS centres to ensure homogeneity and comparability regarding of facility setting, guidelines and practices.

Study design

The study was a prospective cohort study. Respondents were recruited immediately after diagnosis and were followed up for 6 months, with assessments done at baseline, after of completing the intensive phase (first two months of treatment) and within 2 weeks of completing treatment (6 months of treatment) in line with treatment guidelines in Nigeria. The duration of the study was 15 months.

Eligibility criteria

This study recruited individuals aged 15 years and above, classified as new cases i.e. TB patients who have never had treatment for TB, or who have taken anti-TB drugs for less than 4 weeks and diagnosed according to the Nigerian National Tuberculosis and Leprosy Control Program (NTBLCP) guidelines with PTB [23]. Individuals who were severely ill or debilitated and those with pre-existing chronic respiratory disease such as asthma and chronic obstructive pulmonary disease (COPD) (at least a year prior to TB diagnosis) were excluded from the study. Those who had been

treated for any form of TB previously were also excluded from the study. The respondents were selected from facilities that were publicly-owned, had capacity for diagnosis and treatment of patients with TB and or HIV; and had been actively involved in provision of TB treatment services for at least two years.

Sample size determination

Sample size determination was based on the mean difference between global HRQOL score at baseline and 6 months (end of treatment) [24]. The sample size was based on a mean difference of 2.6 (observed in a previous Nigerian study [25]) and a standard deviation 10.0. This resulted in a standardized effect size of 0.26. Using the standardized effect size with a significance level of 0.05 and 90% power, the minimum sample size calculated was 150. Taking into consideration a drop-out rate of 28.7% [16], the final sample size was 210 (See Supplementary material).

Sampling technique

A two-stage sampling technique was used. One local government area (LGA) was selected from each of the three senatorial districts in Lagos State by simple random sampling. One health facility that met the inclusion criteria was then selected from the list of the eligible facilities in each LGA by simple random sampling using balloting. Patients were consecutively recruited until the required number was attained.

Study instruments

We collected data using an interviewer-administered questionnaire. It included information on socio-demographic characteristics such as age, gender, marital status, religious background, and household size. It also included information on education, occupation, employment status, clinical presentation, and medical history. As per guidelines, all patients were also offered HIV counselling and testing. Height was measured to the nearest 0.1 cm and weight was measured to the nearest 0.1 kg.

The World Health Organization Quality of Life Questionnaire-Short Version (WHOQOL-BREF) was used to assess the HRQOL of the respondents. It measures four broad domains namely physical health, psychological health, social relationships, and the environment. It consists of 26 items in total, which are scored on Likert scale of 1–5. Scores are scaled in a positive direction, with higher scores denoting a more optimistic response and a higher quality of life. Negatively-phrased questions are reverse-scored [26]. The physical domain reflects the capacity of the patient to carry out everyday activities. The psychological domain considers facets of the individual's mood and emotional wellbeing. The social relationships domain assesses personal relationships and social support while the environment domain relates to financial resources, the physical environment, opportunity for acquiring new information and skills, participation in recreation and leisure activities. [26]

The psychometric properties of WHOQOL-BREF have been described in more than 11,000 adults from 23 countries, including Nigeria. [26], with domain scores showing evidence of good discriminant validity and construct validity [26]. In Nigeria, WHOQOL-BREF has been applied extensively on people with HIV the elderly, stroke survivors, people with diabetes mellitus, schizophrenia, and hypertension [27, 28]. The Yoruba-translated version has also been validated [28]. The tools were pretested in 20 individuals with TB from a facility not included in any of the study locations.

The internal consistency and the reliability of the WHOQOL-BREF were assessed using Cronbach's alpha coefficient. It is expressed as a number between 0 and 1 and describes the inter-relatedness of the items within the tool [29, 30]. An alpha value equal to or greater than 0.70 was considered acceptable. Cronbach's alpha at baseline was above 0.80 in all the domains. The convergent validity was measured by assessing correlation between the WHOQOL-domains and the global items ("global quality of life rating", and "overall satisfaction with health"). Pearson correlation values between 0.8 and 1.0 are considered strong, 0 0.4 to 0.6 are considered moderate, and 0.0 to 0.2, considered weak. In this study Pearson's correlation coefficient ranged from 0.433 to 0.801(See Table S1).

Data collection

Respondents were recruited in the selected facilities once diagnosed as having PTB. Only respondents who gave an informed consent were recruited. Each respondent was followed up for six months. Respondents received the standard "Regimen 1 TB treatment", which is 6 months of treatment—rifampicin, isoniazid, ethambutol, and pyrazinamide for 2 months (intensive phase), and rifampicin and isoniazid for 4 months. The HRQOL was assessed at baseline, at the end of the 2nd month and at the end of the sixth month. The English and Yoruba versions of the WHOQOL-BREF were used, some of the respondents did not understand English. The general questionnaire was also translated into Yoruba version and was back-translated into English by a person who had no prior knowledge of the original English version. Height and weight were measured after completion of the interview, and body mass index (BMI) was calculated. Results of sputum microscopy were abstracted from patient records during the follow-up visits. Treatment outcomes were classified into four categories as per national guidelines—cured; treatment completed (for bacteriologically-negative cases at onset), treatment failure or loss to

follow-up. Treatment success consisted of 'cured and treatment completed'. Independent variables of interest included patient-related factors such as socio-demographic factors, HIV status and smear -positive status. Three volunteer officers attached to the TB-DOTS clinics were trained as research assistants. They explained the study, obtained informed consent, and administered the questionnaires to the respondents.

Data analysis

Data was analysed using SPSS v23. The HRQOL domain scores were computed and transformed to a score out of 100 as per WHO guidelines for scoring the scale. Mean scores were determined for each domain and the global questions on quality of life and satisfaction with health. Socio-demographic and clinical characteristics were described using frequencies and proportions. A one-way repeated measures ANOVA test with polynomial contrasts was conducted to assess the differences the mean WHOQOL-BREF domain scores in PTB patients at the baseline, 2 months, and the end of 6 months and post-hoc test was used for the pairwise comparison. Greenhouse–Geisser epsilon adjustment was employed if Mauchly's test of sphericity was found to be violated, A Bonferroni correction was applied to adjust for multiple tests. Effect size was measured using partial eta squared (η_p^2), with 0.010—0.050 graded as small, 0.060–0.138, medium and > 0.138, large [31].

Multivariable analysis of changes in HRQOL domains was conducted using generalized estimating equations (GEE) with an auto-regressive correlation structure. The GEE model extends the generalized linear models (GLM) to include longitudinal and correlated data and provides a simple way to analyse the relationship between the responses and the time-dependent covariates [32]. A p-value less than 0.05 was regarded as significant. All variables that were plausibly important and that the data set could support were included as co-variates and not just those that were statistically significant at univariate analysis [33], Sociodemographic characteristics such as age, sex, level of education and employment status were included as covariates in the model. The residuals at each timepoint were checked for normality by drawing the Q-Q plot and using the Shapiro–Wilks test. A *p*-Value of ≤ 0.05 was considered statistically significant.

Ethical considerations

An informed written consent was obtained from all study respondents. Ethical approval was obtained from the LASUTH-HREC (Reference number: LREC/10/06/460), while permission to conduct the study was obtained from the Lagos State Ministry of Health as well as from the individual facilities. Respondents with residual pulmonary function deficits were counselled and referred to the Respiratory Medicine Unit of the Lagos State University Teaching Hospital.

Results

Participant enrolment

Two hundred and thirty patients were screened and 210 were recruited into the study giving a 91.3% screening success rate. Two hundred and seven patients (98.6%) completed the second assessment and 194 (92.4%) completed the third. Almost 7% were lost to follow up and 3.3% had treatment failure. Two patients died, and both were HIV-positive (Fig. 1).

Socio-demographic characteristics of respondents

The ages of respondents ranged between 15 and 70 years, with majority (79.1%), less than 45 years and a mean age of 36.40 ± 11.76 years. A total of 133 (63.3%) were male and 113 (53.3%) were married. Majority (79.6%) had a secondary school education or higher. However, 81.9% (187) had a monthly income of 45,000 Naira or less (105 USD). Almost half (44.7%) were unemployed, with 10% of the respondents reporting they had lost their jobs due to illness. (Table 1).

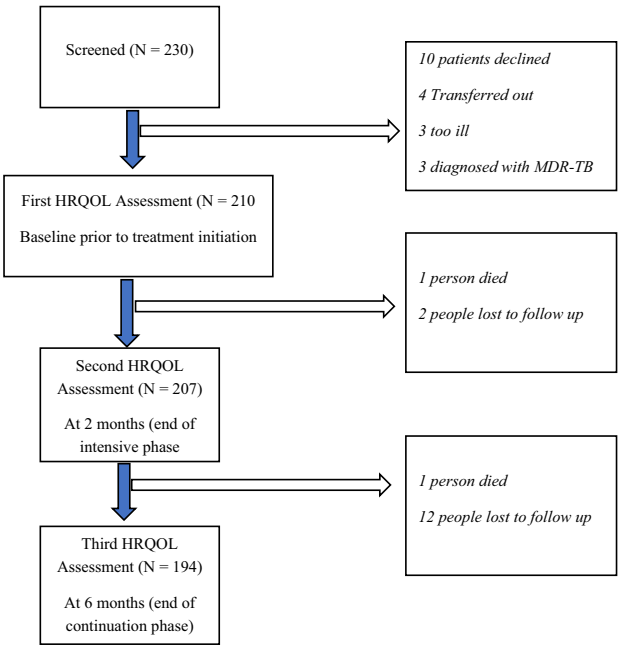

Fig. 1 Participant enrolment and follow-up

Table 1 Socio-demographic characteristics of PTB patients at baseline

Variable	Category	$N=210$ *n* (%)
Age (in years)	≤24	23 (10.9)
	25–34	79 (37.6)
	35–44	62 (29.5)
	45–54	25 (11.9)
	≥55	21 (10.0)
Mean age (years)		36.40 (±11.76)
Sex	Male	133 (63.3)
	Female	77 (36.7)
Marital Status	Single	76 (36.2)
	Married	113 (53.8)
	Separated/divorced	5 (2.4)
	Widowed	3 (1.4)
	No response	13 (6.2)
Highest Educational Qualification*	No formal Education	8 (3.8)
	Primary	34 (16.2)
	Secondary	119 (56.7)
	Tertiary	48 (22.9)
Religion	Christianity	125 (59.5)
	Islam	85 (40.4)
Employment status	Full-time paid employment	25 (11.9)
	Self-employed	79 (37.6)
	Full time student	12 (5.7)
	Lost job due to TB	21 (10.0)
	Unemployed	73 (34.7)
Household size*	<5	158 (75.2)
	5–9	45 (23.3)
	≥10	3 (1.5)
Household Income (Naira)	≤15,000	24 (11.2)
	15,001–29,999	75 (35.6)
	30,000 – 44,999	88 (41.7)
	≥45,000	23 (11.9)
Socio-economic status	High	47 (22.4)
	Middle	70 (33.3)
	Lowest	93 (44.3)

*Missing data—Four respondents did not respond to this question

Clinical characteristics of respondents

Prevalent symptoms among respondents included cough, anorexia, weight loss, chest pain, breathlessness fever and haemoptysis. At presentation, 169 (80.5%) of the respondents presented with a complained of a cough, while 144 (68.6%) had anorexia. Over half of the respondents said they had experienced weight loss, breathlessness, or fever. All these symptoms progressively improved over the course of treatment although almost one in five still had a cough at the end of the sixth month.

Majority (80.5%) had bacteriologically confirmed PTB and about a fifth of the respondents were HIV-positive. Body mass index was classified as underweight, normal, and overweight. Most of the respondents (65.2%) had a normal BMI. However, 58 respondents (27.6%) were underweight at baseline, but this reduced to 12.7% at the end of the sixth month (Table 2).

Health-related quality of life of respondents

There was an increase in the mean scores for each HRQOL domain over the period of treatment. The lowest domain score at baseline was in the 'environment domain' (45.27 ± 14.59) while the highest was in the 'social domain' (50.98 ± 17.37)) and this also remained the highest at the end of the treatment period. Using a one-way ANOVA with repeated measures test there was a statistically significant difference between the means of baseline measurement, 2nd month measurements and 6th month measurements in all four domains. The Greenhouse-Geissler corrected F-ratio was reported for the physical domain as it violated

Table 2 Clinical characteristics of PTB patients at over the period of treatment

Clinical features		Baseline $N=210$	End of 2nd month $N=207$	End of 6th month $N=194$
Symptoms at presentation**	Cough	169 (80.5)	130 (62.8)	41 (19.8)
	Anorexia	144 (68.6)	30 (14.5)	20 (10.3)
	Weight loss	121 (57.6)	34 (16.4)	14 (7.2)
	Chest pain	119 (56.7	53 (25.6)	29 (14.9)
	Dyspnoea/breathlessness	114 (54.3)	42 (20.3)	14 (7.2)
	Low-grade Fever	106 (50.5)	47 (22.7)	29 (14.9)
	Haemoptysis	96 (45.7)	32 (15.4)	16 (8.2)
Bacteriological status at diagnosis	Smear positive/MTB detected	169 (80.5)	9 (4.3)	7 (3.6)
	Smear negative/ MTB not detected	41 (19.5)	198 (95.7)	187 (96.4)
HIV status	Positive	43 (20.5)	N/A	N/A
	Negative	167 (79.5)	N/A	N/A
BMI at presentation (kg/m^2)	Underweight (< 18.5)	58 (27.6)	41 (20.2)	25 (12.7)
	Normal (18.5—24.9)	137 (65.2)	146 (71.9)	147 (75.8)
	Overweight (≥ 25)	15 (7.2)	16 (7.7)	22 (11.3)
Adverse drug reactions (ADR)	Experienced ADR		7 (3.4)	2 (1.0)
	No ADR experienced	N/A	200 (96.6)	192 (99.0)
Treatment outcome	Treatment completed/Cured			187 (89.0)
	Lost to follow-up	N/A	N/A	14 (6.7)
	Treatment failure			7 (3.3)
	Death			2 (1.0)

**More than one option allowed

N/A not applicable, *PTB* pulmonary tuberculosis, *MTB mycobacterium tuberculosis*

the assumptions for sphericity. Partial eta squared ranged between 0.178 and 0.295. There was an improvement in HRQOL at both the 2nd and 6th month assessments except for the physical domain where there was a slight fall at the 6th month measurement. At baseline, only 28 patients (13.5%) expressed general satisfaction with their health, but this increased to 55.7% ($n=108$) at the end of treatment. (Table 2).

For all the domains, the mean differences between first- and 2nd-month measurements were all higher than the corresponding difference between the 2nd- and 6th- month measurements. The largest mean difference between 2nd- and 1st-month measurements were in the overall satisfaction with health rating. This was followed by the physical domain and the psychological domain. Although the highest domain scores at baseline, the 2nd- and 6th- month measurements were in the social domain, it had the least increments in mean differences compared to the other domains. (Table 3). There was a statistically significant linear trend observed across all the domains. Although the *p*-values for the quadratic trends were also significant (except for the global quality of life rating), the partial eta-squared is lower suggesting that the linear trend is a better fit.

The effect size between baseline and six-month measurements was large across all the domains except for the global quality of life domain, which was medium. Differences between mean measurements at the baseline and 2nd-month also followed a similar pattern. Effect size was generally smaller for change in HRQOL between the 2nd- and 6th-month measurements (Table 4).

Factors influencing quality of life

Multivariable analysis of factors influencing change in HRQOL domain scores are presented in Table 5. There was improvement in HRQOL scores across all the domains over time, adjusting for other factors. Patients who were employed had significantly higher scores in the physical ($\beta=4.723$, $p=0.003$), psychological ($\beta=5.624$, $p=0.001$), social ($\beta=5.059$, $p=0.005$) and environmental domains ($\beta=4{,}073$, $p=0.019$). The presence of persisting symptoms was negatively associated with all six domains. A delay in

Table 3 Serial measurements of the WHOQOL-BREF domain scores

WHOQOL-BREF Domains	Baseline mean (SD)	End of 2nd month Mean (SD)	End of 6th month Mean (SD)	Eta effect size	F	Polynomial contrasts
Physical	47.07 (16.55)	60.19 (13.29)	59.45 (10.88)	0.24	73.16	Linear, F = 89.982 $p < 0.001$, ηp2 = .311 Quadratic, $F = 51.347$ $p < 0.001$, ηp2 = .205
Psychological	47.06 (16.89)	58.98 (14.39)	63.26 (15.17)	0.27	74.03	Linear, $F = 115.922$ $p < 0.001$, ηp2 = .368 Quadratic, $F = 13.457$ $p < 0.001$, ηp2 = .063
Social	50.98 (17.37)	60.55 (14.83)	64.63 (16.14)	0.18	42.98	Linear, $F = 76.245$ $p < 0.001$, ηp2 = .277 Quadratic, $F = 5.290$ $p = .022$, ηp2 = .026
Environment	45.27 (14.59)	56.10 (14.44)	61.28 (15.86)	0.29	76.39	Linear, $F = 148.987$ $p < 0.001$, ηp2 = .428 Quadratic, $F = 8.159$ $p = .005$, ηp2 = .039
Global quality of life rating	61.34 (18.59)	66.17 (13.91)	69.43 (12.34)	0.07	15.94	Linear, $F = 27.189$ $p < 0.001$, ηp2 = .120 Quadratic, $F = 0.258$ $p = .612$, ηp2 = .001
Overall Satisfaction with health	39.27 (18.87)	54.73 (18.78)	62.00 (18.36)	0.33	100.11	Linear, $F = 192.514$ $p < 0.001$, ηp2 = .490 Quadratic, $F = 8.831$ $p = .003$, ηp2 = .042

WHOQOL-BREF World Health Organization Quality of Life Questionnaire-Short Version; *SD* standard deviation

Table 4 Pairwise comparisons of HRQOL domain measurements (post-hoc analysis)

	T3—T1 (6 months)			T3—T2 (4 months)			T2—T1 (2 months)		
WHOQOL-BREF Domain	Mean difference	Standard error	effect size (η_p^2)	Mean difference	Standard error	effect size (η_p^2)	Mean difference	standard error	effect size ($\eta_p^{2)}$
Physical	12.45*	1.31	0.309	− 0.93	1.07	0.004	13.38*	1.31	0.341
Psychological	16.09*	1.49	0.371	4.10**	1.32	0.046	11.99*	1.30	0.299
Social	13.42*	1.54	0.277	3.83**	1.49	0.032	9.58*	1.45	0.181
Environmental	16.09*	1.32	0.427	5.00*	1.22	0.078	11.09*	1.29	0.270
Global quality of life rating	7.84*	1.50	0.119	3.39**	1.13	0.043	4.48**	1.52	0.042
Overall satisfaction with health	22.64*	1.63	0.488	7.09*	1.64	0.086	15.55*	1.64	0.308

WHOQOL-BREF World Health Organization Quality of Life Questionnaire-Short Version

presentation had a negative effect on social domain scores ($\beta = -3.797$, $p = 0.011$), but a positive effect on change in environmental domain scores ($\beta = 4.347$, $p = 0.005$). An improvement in BMI had a positive effect on scores in the physical, psychological, and social domain, as well as overall satisfaction with life and global quality of life scores.

Table 5 Generalized estimating equation (GEE) model for factors predicting changes in WHOQOL-BREF domain scores

Variable	Physical			Psychological			Social			Environment			Global HRQOL			Overall Satisfaction		
	B	SE	*p*-Value	β	SE	*p*-Value	B	SE	*p*-Value	*β*	SE	*p*-Value	*β*	SE	*p*-Value	*β*	SE	*p*-Value
Period (Index)																		
Baseline (ref)																		
2 months	12.731	1.307	**<0.001**	11.361	1.338	**<0.001**	9.560	1.473	**<0.001**	10.320	1.395	**<0.001**	3.710	1.556	**0.017**	15.877	1.751	**<0.001**
6 months	11.494	1.299	**<0.001**	15.014	1.520	**<0.001**	13.528	1.603	**<0.001**	15.020	1.333	**<0.001**	6.534	1.542	**<0.001**	22.286	1.724	**<0.001**
Age (years)	0.065	0.053	0.217	0.010	0.059	0.863	0.064	0.062	0.297	0.013	0.057	0.820	0.027	0.052	0.596	0.143	0.066	**0.030**
Gender																		
Male (ref)																		
Female	− 1.457	1.328	0.272	0.323	1.553	0.835	− 0.677	1.549	0.662	− 0.565	1.505	0.707	− 0.781	1.506	0.604	− 0.185	2.113	0.930
Marital Status	-2.980	1.463	**0.042**	− 3.856	1.707	**0.024**	-2.528	1.779	0.155	-3.409	1.709	**0.046**	-3.253	1.610	**0.043**	-1.025	2.052	0.617
Single (ref)																		
Married	− 2.980	1.463	**0.042**	− 3.856	1.707	**0.024**	− 2.528	1.779	0.155	− 3.409	1.709	**0.046**	− 3.253	1.610	**0.043**	− 1.025	2.052	0.617
Educational level																		
None/Primary (ref)																		
Secondary	− 0.614	1,874	0.743	− 0.873	2.179	0.688	− 0.398	2.242	0.859	− 1.826	2.162	0.398	0.237	2.012	0.906	− 0.731	2.747	0.790
Tertiary	5.527	3.164	0.081	5.053	3.665	0.168	4.870	3.126	0.119	3.993	3.898	0.326	8.194	3.202	**0.010**	8.217	3.883	**0.034**
Socio-economic status																		
Low (ref)																		
Middle	1.248	2.629	0.635	0.856	3.135	0.785	1.610	2.488	0.518	0.627	3.413	0.854	5.054	2.654	0.057	3.311	2.904	0.254
High	2.721	2.698	0.313	− 1.069	3.197	0.738	1.697	2.815	0.547	0.505	3.429	0.883	2.324	3.013	0.441	1.845	3.100	0.552
Employment status																		
Unemployed (ref)																		
Employed	4.273	1.437	**0.003**	5.654	1.680	**0.001**	5.059	1.788	**0.005**	4.073	1.743	**0.019**	2.747	1.471	0.062	4.758	1.994	**0.017**
Persisting symptoms																		
Present																		
Absent	4.946	1.310	**<0.001**	4.847	1.440	**0.001**	6.269	1.536	**<0.001**	5.663	1.401	**<0.001**	3.816	1.479	**0.010**	5.228	1.787	**0.003**
Symptom duration																		
<4 weeks (ref)																		
≥4 weeks	− 1.103	1.318	0.403	− 2.535	1.517	0.095	− 3.797	1.490	**0.011**	4.347	1.564	**0.005**	0.277	1.443	0.848	3.501	1.838	0.057
BMI	0.506	0.163	**0.002**	0.401	0.173	**0.020**	0.222	0.201	0.269	0.539	0.174	**0.002**	0.478	0.192	**0.013**	0.456	0.227	**0.044**
HIV Status																		
Positive (ref)																		
Negative	0.608	1.673	0.716	2.163	1.827	0.236	2.673	1.911	0.162	1.650	1.758	0.348	3.564	1.814	**0.049**	2.901	2.502	0.246

Bold values denote statistical significance at $p < 0.05$ level

B beta coefficient, *SE* standard error, *BMI* body mass index

Discussion

This study assessed the changes in HRQOL using the WHO QOL-BREF tool in 210 newly-diagnosed adult PTB patients during a standard 6-month DOTS treatment. Majority were within the ages of 25 and 55 years of age and at baseline, 80.5% were bacteriologically diagnosed, while 20.5% had HIV co-infection. The study showed that HRQOL was impaired in patients with TB at the treatment initiation but improved over the course of treatment. Mean domain scores at baseline ranged between 45.27 and 50.98, far below normative values proposed by researchers in Australia and Brazil [34, 35]. To our knowledge, normative values have not been established by Nigerian studies. However, the mean scores across all the domains were also lower than those recorded in two earlier cross-sectional studies done in Nigeria [17, 36]. This may be reflective of the differences in the study population. In one of the studies, patients had been on treatment for at least two months [37], while in the other, patients selected were at varying states of treatment [17]. Both studies were also conducted in a teaching hospital. The mean scores across all domains were higher than that reported by a study in Ethiopia however about 72% of that study population were rural dwellers [38].

At baseline, the lowest scores were recorded in the environment domain which relates to financial resources, physical environment, security, and home environment. This is buttressed by a high proportion of respondents who were in the lower socio-economic group. It may also be related to the high level of unemployment among the study participants which adversely affects income. A previous study conducted in North-Central Nigeria also found that the environment domain was the worst affected domain at baseline [36]. However, our findings were in contrast with several studies where the physical domain was the worst affected [20, 39, 40]. In our study, the physical domain was the second worst-affected domain. However, the greatest improvement at the end of the 2nd month (intensive phase) was in this domain. It is thought to be as a result of resolution of clinical symptoms, and this has also been corroborated by previous studies [41, 42].

The highest score was in social relationships. These finding is similar to an earlier study conducted in a teaching hospital in Lagos state where the highest score was also in the social domain (70.80 ± 18.12) [17]. This may be as a result of a strong perception of family support by TB patients [43]. A study in Saudi Arabia also found the social domain was least affected among drug-sensitive TB patients and this was attributed to religion as well as cultural factors [44]. Similarly, the highest domain scores were reported in the social domain in studies from Taiwan and India [45, 46]. In contrast to this, mean scores in the social domain were most affected for PTB patients in Gondar, Ethiopia. However in this study over half of the respondents were single or divorced which may lend credence to the importance of family relationships [38]. Studies done among those with HIV/AIDS in Nigeria show that the social relationships domain is often the worst affected domain which suggests that experiences of stigma may be different for those with HIV co-infection [47, 48].

There was a significant improvement in WHOQOL-BREF domain scores with anti-TB treatment, demonstrating the positive impact of therapeutic intervention. This is corroborated by the patients' subjective assessment with their health, with over half expressing satisfaction with their health by the end of treatment. Findings in our study were in keeping with an earlier study conducted in a Nigerian teaching hospital in which domain scores at the third assessment were significantly better than the corresponding scores at the first assessment [20]. This was also seen in a study by Agarwal et al. in India [14]. In both studies, the largest differences between measurements at baseline and 6 months were in the physical followed by the social domain. In the present study the physical domain also had the most marked increase, but this was followed by the environment domain. In the both these studies, differences were more marked between the second and first assessments compared to the third and second assessments. This was a similar finding in our study except for the physical domain. These findings were in contrast to findings from a study in Eastern Taiwan where there was an initial decrease in all four domain scores between baseline and 2 months followed by an increase by the end of 6 months [49]. The prominence of adverse reactions at the 2-month period compared to the other two periods, was a plausible explanation for this observation.

Few studies have examined pairwise comparisons between the different timepoints of TB treatment [14, 50], In the present study, the effect size of the change in mean domain scores from baseline to the sixth-month of treatment (T3–T1) was larger than other comparisons, The effect size was also generally larger across all domains when comparing second and baseline measurements (T3–T1) with third and second measurements (T2–T1). This pattern is in keeping with an earlier study conducted in India [14] and corroborates findings from earlier studies that the most substantial improvement in HRQOL occurred during the intensive phase [51].

Factors that were associated with quality of life in our study such as educational status, BMI, delay in seeking treatment and employment status have been corroborated by findings from other studies [16, 17, 52–54]. Measurements of HRQOL taken at the end of treatment revealed that the largest deficit was in the physical domain. This is suggestive of residual impairment of HRQOL even at treatment

completion and is supported by the negative association between the presence of persisting symptoms and change in scores across all the domains. This is not a surprising finding, given the chronic and often destructive nature of PTB.

The study had some limitations. The domains are subjective and self-reported by patients. However, previous studies have shown that the domain scores of the WHOQOL-BREF have shown evidence of good convergent, construct and discriminant validity [45]. The study may be affected by Hawthorne effect whereby respondents alter aspects of their behaviour as a result of being studied repeatedly. Interviewers were well-trained to make sure that respondents did not feel that their answers had to please the interviewer. The findings of the study are limited to patients seen in publicly owned facilities and those with pulmonary TB. It is also possible that there were other factors beyond the scope of our study which influenced HRQOL.

In conclusion, HRQOL in patients with TB improves with treatment. Patient attributes showed significant association more with the psychological domain. Early presentation is significantly associated with the domains of quality of life assessed at baseline and at the end of treatment. We recommend that efforts be concentrated on interventions that encourage early presentation and identification of patients with TB and that patient be provided with individualized psycho-social support. This present study also highlights the need for increased recognition and incorporation of patient-reported outcomes as an adjunct outcome measure. The scope of future research should be expanded to assess health-related quality of life among patients with extrapulmonary TB and those with multi-drug resistant tuberculosis. Research needs to be done to further elucidate other factors that may affect quality of life.

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Author contributions All the authors contributed to the study conception and design. BA managed the study, performed statistical analyses, and wrote the first draft of the manuscript. OA participated in interpretation and presentation of research findings and helped write the final draft. OO participated in designing data management strategies and presentation of research findings and extensively revised the manuscript. OO also supervised the original dissertation. All authors read and approved the final manuscript.

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Data availability Datasets supporting this article are available upon request to the corresponding author. Due to data protection restrictions and participant confidentiality, participants' data is not made publicly available.

Declarations

Competing interests All the authors declare that thy have no relevant financial or non-financial interests to disclose.

Ethical approval The study was conducted upon receipt of ethical approval from Lagos State University Teaching Hospital (LASUTH) Health Research Ethics Committee (Reference number: LREC/10/06/460). Permission to conduct the study was also obtained from the Lagos State Ministry of Health as well as from the management of the individual health facilities.

Informed consent A written informed consent was obtained from the respondents prior to the study. For respondents under the age of 18 years, an assent was obtained from them, while consent was obtained from their parents/guardians. The goals and objectives of the study were explained to study participants, and they were also informed that participation or non-participation in the study would have no impact on provision of healthcare. Information gotten was also anonymized by removing personal identifiers. Participation in the study was voluntary, and individuals were free to withdraw or stop the interview at any time.

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