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Socioeconomic consequences of tuberculosis for households in Nigeria: A longitudinal patient cost survey within an intervention engaging informal health providers

Beatrice Wangari KIRUBI
Stop TB Partnership
Suraj Abdulkarim
Sufabel community development initiative
Stephen John
Janna Health Foundation, Yola, Adamawa State, Nigeria
Emperor Ubochioma
National TB and Leprosy Program, Federal Ministry of Health Nigeria, Abuja, Nigeria
Tushar Garg
Stop TB Partnership
Md. Toufiq Rahman
Stop TB Partnership
Rachel Forse
Friends for International TB Relief
Jacob Creswell
jacobc@stoptb.org

Stop TB Partnership

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Abstract

Introduction

Tuberculosis (TB) imposes a significant economic and social burden on affected households, particularly in low- and middle-income countries income settings. In Nigeria, many people with TB first seek care from informal healthcare providers. This study assessed the economic and social consequences of TB among patients referred by informal providers in Northeast Nigeria.

Methods

A longitudinal patient cost survey was conducted alongside a case-finding intervention engaging informal providers in Adamawa and Yobe states between July and December 2022 among adults with drug-susceptible pulmonary TB referred by traditional healers or patent and proprietary medicine vendors. Participants (n = 195) were interviewed at three time points during treatment to collect data on direct and indirect costs, household income and other socioeconomic consequences.

Results

The mean total cost of a TB episode was US$187 (95% CI 170–203), with direct costs accounting for 68% of total expenditures. Despite lower average costs compared to national estimates, 27% (n = 53) of households incurred catastrophic costs. Food insecurity was reported by 62% (n = 122) of households during treatment. Lower pre-TB household income was strongly associated with incurrence of catastrophic costs and adverse social outcomes, including job loss and stigma.

Conclusions

Engaging informal providers in TB referral may contribute to lower patient costs compared with national estimates, but substantial economic and social consequences remain. Strengthening social protection measures is needed to mitigate the broader socioeconomic impact of TB particularly among vulnerable households.

Key Message

What is already known on this topic

Tuberculosis (TB) imposes significant economic and social burdens on households in Nigeria, with national surveys estimating that 67% of TB-affected households incur catastrophic costs. Informal healthcare providers such as traditional healers and medicine vendors are frequently the first point of contact for people with TB seeking care.

What this study adds

In Northeast Nigeria, where informal providers were engaged in TB referral, the average cost of a TB episode was US$187 and 27% of households incurred catastrophic costs. Food insecurity and other adverse social consequences were common. Pre-TB household income was the strongest determinant of financial vulnerability and household income recovery.

How this study might affect research, practice or policy

Engaging informal providers may support earlier TB diagnosis and reduce some patient costs, but additional social protection is needed to address persistent food insecurity and socioeconomic vulnerability among TB-affected households. Additionally, catastrophic costs, whilst still a useful measure, does not depict the true impact of the socioeconomic impact of TB particularly among people with low incomes.

INTRODUCTION

Nigeria has one of the highest tuberculosis (TB) burdens, ranking 6th globally and highest in Africa (1). With a population of 233 million, the country accounts for 4.6% of all incident TB (1). Although the country has made significant progress in finding and treating people with TB there is still a wide gap between the number of cases estimated and those notified(1). In 2023, about 75% of the estimated 499,000 people who developed TB 2023 were notified and linked to treatment, meaning one in four (more than 120,000) people who developed TB were missed by the national program (2). To address this, the Nigerian National Strategic Plan for TB (2021–2025) aims to expand access to high-quality, community-led TB services (3). A key focus of this strategy is strengthening engagement with private healthcare providers and community-based organizations to find missing cases and improve linkage to care (3). Approximately 60% of people with TB initially seek care in the formal or informal private sector (4), which is comparable to other low- and middle-income countries (LMICs) (5). More specifically, an estimated 21% of people who fall ill with TB in Nigeria access services through the informal private sector, which includes traditional healers (TH) and drug sellers, commonly referred to as Patent and Proprietary Medicine Vendors (PPMVs) (4).

In Nigeria, a traditional healer (TH) is a person without formal medical training who is recognized by the community as being able to provide health care by using plant, animal and mineral substances and certain other methods(6); Patent and Proprietary Medicine Vendors (PPMVs) are persons without formal pharmacy training who sell orthodox pharmaceutical products on a retail basis for profit”(7). In this study, "informal providers" encompasses both THs and PPMVs.

Existing literature presents mixed findings on the role of informal providers in TB care. In some settings, they have improved equitable access to health services for many diseases, including TB (7–10). Studies indicate that many people with TB initially seek care from informal providers, and therefore engaging them in TB care could facilitate timely and appropriate referrals to the formal health system (5, 11–14).

However, informal providers have also been associated with more complicated patient pathways, delays in diagnosis and concerns about the quality of care and inappropriate treatment (11, 15). Despite these challenges, informal providers remain a preferred choice in many LMICs due to their geographical accessibility, flexible service hours, and deep-rooted trust within communities (16). Additionally, the high costs of formal private healthcare can be prohibitive, particularly for poorer populations and key affected groups (17, 18). Some informal providers also accept non-monetary payments, such as livestock, making healthcare more accessible for marginalized communities (17).

While engaging informal providers may improve access to TB services, the impact of the engagement on the economic burden faced by people with TB remains unclear. Nigeria is one of the high TB burden countries with high catastrophic health expenditures, affecting over 15% of the country's population (19). Specifically among people with drug-susceptible TB (DS-TB), more than 67% incur catastrophic costs, spending at least 20% of household income on TB care(1, 20). Studies have linked informal providers to delays in TB diagnosis and potential increases in out-of-pocket expenses in Nigeria (21). However, there is a paucity of studies documenting the economic burden of TB when informal providers are actively engaged in TB care with effective early referral mechanisms in place.

We aimed to assess the economic and social burden faced by people with TB through a study that engaged informal providers for diagnostic referrals. We hypothesized that engaging informal providers would reduce the overall TB-related costs, primarily by lowering pre-diagnostic expenses and facilitating earlier treatment, thereby reducing the severity of illness and subsequent treatment costs. The primary objective was to quantify the costs and estimate the proportion of households affected by catastrophic costs due to TB. Secondary objectives included estimating the proportion of households facing adverse socioeconomic consequences. Additionally, the study sought to identify key cost drivers, compare the economic and social impact of TB between those seeking care from THs and PPMVs, and determine factors associated with incurring catastrophic costs.

METHODS

Study design and setting

This longitudinal patient cost survey (PCS) was conducted alongside a case-finding intervention in Adamawa and Yobe states, northeast Nigeria, between July-December 2022. The Northeast region has the lowest household consumption expenditure, suggesting a lower cost of living compared to other regions in the country (22). Since 2014, this region has faced Boko Haram insurgency, communal clashes, and farmer-grazer conflicts, resulting in destroyed health infrastructure and over 2 million displaced people. The project targeted four Local Government Areas (LGAs): Shelleng and Ganye in Adamawa state and Bade and Nguru in Yobe state, covering a population 947,700 in 2022 (23). Among the 186 health facilities in the four LGAs, 30 were DOTS facilities (providing TB diagnostic and treatment services). Based on previous interventions in the area, communities heavily relied on THs and medicine vendors, widely accepted as informal providers for various health conditions, including pulmonary complaints.

TB care in this setting is delivered through a decentralised model under the National TB Programme (NTP), primarily at primary healthcare facilities and selected public–private mix (PPM) DOT centres, with specialised services for drug-resistant TB available at designated state treatment centres. TB consultations, diagnostics and first-line medicines are generally provided free of charge through the NTP, although some ancillary medicines and chest radiographs may incur out-of-pocket costs, and there is currently no health insurance coverage for TB care or related hospitalisations.

Intervention

The intervention involved improving TB detection through symptom screening and referrals by informal providers and community volunteers to the 30 DOTS public facilities. Informal providers in the four LGAs were mapped, selected based on caseload, and trained to verbally screen for TB symptoms and identify people with presumptive TB. Informal providers were paired with community volunteers responsible for sputum transport, liaising with TB program officials, and providing treatment support. A total of 120 PPMVs and 60 THs were trained and linked to 40 community volunteers to manage presumptive TB cases. A more in-depth description of the intervention is available in a separate publication(24).

Sample size calculation, sampling and eligibility criteria

We estimated a sample size of 185 people with TB. Using the 69% catastrophic cost incurrence rate among people with DS-TB in the national cost survey [11], we used 80% power to detect a 15% reduction in catastrophic costs from the intervention at 95% confidence, and with 25% contingency for loss to follow-up. A two-sample proportion comparison was used to compare people referred by THs and PPMVs. People with TB were consecutively sampled from facility TB registers. All eligible patients registered for treatment and attending the selected facilities during the survey period were referred by DOT staff for recruitment in the order they appeared in the register until the required sample size was reached. Eligible participants were adults (18+) with pulmonary DS-TB, referred to the health system by engaged informal providers. Patients hospitalised during the first two weeks of treatment and those who declined participation were excluded.

Data collection

Data were collected through face-to-face interviews using a structured, locally adapted version of the WHO PCS tool (25, 26). This questionnaire, previously used in Vietnam(27), was tailored for Nigeria with input from local stakeholders (see supplemental material 1). The adapted tool assessed participant characteristics, costs, and social consequences associated with TB. Specifically, these included data on out-of-pocket medical and non-medical costs, indirect costs (income and time loss); and changes in employment status, food insecurity, social exclusion and coping strategies. Clinical data on TB diagnosis and treatment were extracted from patient registers. Interviews were conducted in English or Hausa depending on participant preference. Interviewers were trained by the implementing partner and LGA TB

officials. Eligible individuals were invited to participate, informed about the study purpose and given an opportunity to ask questions, before signing a written informed consent, or a thumbprint as appropriate.

Nigeria's DS-TB treatment regimen spans six months, with two months of intensive phase and four months of continuation phase. Costs and social impacts were assessed at three points: after two weeks of treatment (covering symptom onset to interview), two weeks post-intensive phase, and two- three months into the continuation phase of treatment. Prior to the follow up interviews, community volunteers contacted the participants to set a time for the interview and coordinate the dates with a drug pick up appointment.

Interview schedules were coordinated with drug pick-up appointments and kept flexible to accommodate participants' availability and support timely medicine collection. To minimise loss to follow-up, participants were contacted by phone and, when necessary, through home visits if appointments were missed. The study team worked closely with community health workers, TB clinics and DOT facilities to maintain contact and support continued engagement in care. Detailed locator information, including contact details of family members or friends, was collected at baseline to facilitate tracing if participants relocated.

Data completeness and consistency were checked after each interview against treatment cards, with quality control by the project coordinator and data manager. Costs were collected in Nigerian Naira (NGN) and converted to US dollars (US$) using average 2022 OANDA exchange rates(28).

Costs and income data

We collected data on monthly personal and household income for each treatment period and estimated direct medical, direct non-medical, and indirect costs from a patient perspective. Direct medical costs included expenses for medications, diagnostic tests, consultations, and hospitalizations, while direct non-medical costs covered transportation, food and supplements and traditional medicines. Indirect costs were calculated using the human capital approach to estimate income loss using Nigeria's 2022 minimum wage (NGN 30,000 or USD 42)(29). The cost data captured expenses incurred during different phases of the TB episode, aggregated to estimate the cumulative cost of the TB episode. Additionally, time spent traveling to health facilities and waiting for appointments was valued using the hourly minimum wage, with total indirect costs calculated as the sum of income and time lost. To estimate the monthly household income, two approaches were used. Where possible, respondents reported income for each income-earning household member, which was aggregated to estimate total household income. In addition, participants selected from predefined income ranges based on Nigeria Demographic and Health Survey (DHS) estimates. The midpoint of the selected range was used in the analysis when the exact amount was uncertain or for outlying values.

Socioeconomic impact of TB

The primary outcome of the study was the incurrence of catastrophic costs, defined as TB-related expenses surpassing 20% of the household's annual pre-TB income [10]. Secondary outcomes included changes in poverty headcount, coping strategies, social consequences, and employment status. Household impoverishment was assessed by comparing pre- and post-TB poverty headcount ratio, using the international poverty threshold of US$1.90 per day (2011 purchasing power parity, PPP). We also documented the frequency of coping strategies, such as borrowing money or selling assets, and the social consequences including food insecurity, social exclusion, stigma, and changes in employment status among others. To explore the distribution of catastrophic costs and those most severely affected, a subpopulation analysis was carried out by residence, gender and pre-TB annual household income.

Statistical analysis

Quantitative data were cleaned and analyzed using Stata IC/18 (30). Descriptive statistics, including means with standard deviations (SD), medians with interquartile ranges (IQR), and proportions, were used to describe the characteristics of the DS-TB cohort. Categorical variables were compared using Pearson's chi-square or Fisher's exact tests. For continuous variables the student's t test and Mann Whitney test were used for variables with normal distribution, ordinal variables and skewed continuous variables respectively. A p-value of < 0.05 was considered statistically significant. Wilcoxon rank-sum tests compared median costs between the TH and PPMV cohorts. Missing data were excluded, and denominators were reported for any deviations from the total sample size. Univariable and multivariable logistic regression models were used to assess the association between catastrophic costs and the TH/PPMV cohort, as well as other demographic and socioeconomic characteristics. Age, sex, and LGA residence were adjusted for in the multivariable regression model. All hypotheses' tests were two-sided, and statistical significance was set at $p < 0.05$. A deterministic sensitivity analysis was conducted to assess the impact of varying catastrophic cost thresholds and comparing different approaches of estimating income loss (See supplemental material 2). Additionally, the prevalence of catastrophic health expenditure was calculated using only the SDG benchmark for financial protection (31).

Ethical considerations

The study protocol for the intervention was reviewed and approved by the Adamawa State Research Ethical Committees in the Ministry of Health Adamawa (no. 2022069). Written consent was provided by all participants. All data were anonymized prior to analysis. The study adhered to the tenets of the Declaration of Helsinki

RESULTS

Out of 199 eligible participants, 195 consented and were recruited into the study, while four were not enrolled because they were unable to provide informed consent due to language barriers. The final sample therefore exceeded the estimated minimum sample size of 185 participants. Among those included in the final analysis, 47% (n = 87) were referred by an engaged PPMV and 53% (n = 108) were referred by an engaged TH. Majority of the participants were male (63%), the mean age was 41 years, and

the average household size was 5. In 69% of the households, the person with TB was also the head of the household. One participant (n = 1) reported having health insurance coverage. Table 1 describes the basic characteristics of the participants. Participants referred by THs had less years of formal education ($p < 0.01$), lower individual and household income prior to TB illness ($p = 0.02$) and had a higher proportion of people living under the poverty line ($p < 0.01$).

Table 1
Baseline characteristics comparing people referred by medicine vendors and traditional healers

Variable		**Total n = 195**	**Referred by PPMV n = 87 (%)**	**Referred by TH n = 108 (%)**	
	Characteristic	**N (%) ***	**n (%) ***	**n (%) ***	**P value****
Sex	Male	122 (63)	52 (60)	70(65)	0.5
	Female	73 (37)	35 (40)	38 (35)	
Age of patient (years)	Mean, (min, max)	41 (20,85)	39 (20,78)	42 (20, 85)	0.3
Individual with TB is head of household	Yes	134 (69)	63 (72)	71 (65)	0.3
Years of schooling	Median, IQR	12 (0–12)	12 (0–12)	3 (0–12)	**< 0.01**
Household size	Median, (IQR)	5 (4–6)	5 (5–6)	5 (4–6)	0.7
Earning income before TB	Yes	137 (70)	64 (74)	73 (68)	0.3
Monthly Individual income prior to TB illness (USD)	Median, IQR	67 (36–120)	77 (48–144)	58 (32–96)	**< 0.01**
	Mean, 95%CI	93 (80–106)	114 (93–134)	76 (60–92)	**< 0.01**
Monthly household income before TB (USD)	Median, IQR	101(70–144)	120 (72–156)	96 (68–144)	**0.03**
	Mean, 95%CI	121 (109–132)	135 (116–154)	109 (93–125)	**0.05**
Households living in poverty	Yes	83 (43)	29 (33)	54 (50)	**< 0.02**

*Mean (95% confidence interval) or median (Interquartile range) where applicable**Significant differences between cohorts tested using chi-squared test/ Fisher's exact test/ Wilcoxon rank-sum tests, as applicable ***Threshold at <$1.9/day, 2011 PPP)

On average, participants had four encounters with the health system before receiving a diagnosis (IQR: 2–5), which is the point where the intervention occurred. Overall, participants experienced a total of 19 encounters throughout the TB episode (IQR:14–21). There were no significant differences in the number of encounters between referrals from THs and PPMVs, either during the pretreatment phase or across the entire episode of care.

Costs for TB care

The total cost of a TB episode was USD 187 (95% CI: 170–203). Direct costs were the largest contributor to the total costs USD 128 (95% CI: 120–136). During the pre-treatment phase, medical costs accounted for 73% of the out-of-pocket costs. People referred by the PPMV incurred significantly higher costs overall (USD 206 vs 172, p = 0.04), particularly driven by the significantly higher medical costs (USD 42 vs 26, p = p < 0.01) and higher indirect costs (USD 59 vs 36, p = p < 0.02) during treatment. There were no significant differences in the pretreatment costs incurred. Table 2 summarizes the TB related costs by referring provider.

Among direct non-medical costs, transportation and food were the main cost drivers. Transportation accounted for 53% of non-medical costs with a mean cost of USD 32 (95% CI: 29–34), while food accounted for 38% with a mean cost of USD 23 (95% CI: 21–25). Other non-medical costs were comparatively small, averaging USD 5 (95% CI: 3–5).

Table 2: **Itemized costs by referring provider and treatment phase**

Table 2
Comparing costs incurred for TB by referring provider*

Cost item	All participants (N = 195) mean (95%CI)	PPMV (n = 87) mean (95%CI)	TH (n = 108) mean (95%CI)	P value***
Pre TB treatment				
Direct costs Pre-treatment	51 (44–57)	49 (37–60)	52 (44–60)	0.66
Medical direct costs	37 (30–43)	35 (25–45)	39 (31–46)	0.56
Non-medical direct costs	14 (12–15)	14 (11–16)	13 (12–15)	0.66
Indirect cost**	13 (10–16)	11 (7–16)	14 (9–19)	0.38
During TB Treatment				
Direct costs during treatment	77 (72–82)	86 (79–83)	70 (63–77)	**< 0.01**
Medical costs	33 (30–36)	42 (37–46)	26(22–30)	**< 0.01**
Non-medical costs	44 (41–48)	45 (39–50)	44(39–49)	0.8
Indirect costs during treatment	45 (36–56)	59 (43–75)	36(22–49)	**0.02**
Costs for TB episode by category				
Direct costs TB episode	128 (120–136)	135 (121–149)	122 (112–132)	0.13
Total medical costs	70 (63–77)	76(65–88)	65 (57–73)	0.11
Total non-medical costs	58 (54–62)	59 (52–65)	57 (52–63)	0.73
Indirect costs total episode	58 (46–70)	70 (53–88)	50 (33–69)	0.09
Total costs TB episode				
Total costs pre-treatment	63 (55–71)	60 (47–73)	66(56–76)	0.47
Total costs during treatment	123 (111–136)	145(127–164)	106(89–123)	**< 0.01**
Total costs TB episode	187 (170–203)	206 (182–229)	172 (149–195)	**0.04**

*Costs expressed in USD (2022) rate; **Indirect costs estimation using human capital approach (HCA) *** significant differences highlighted in bold; Comparison of cohorts tested using Welch's t-test (unequal variances).

Adverse social and economic consequences on the household

Twenty seven percent (27%, n = 53) of TB affected households incurred catastrophic costs, which was comparable in both PPMV and TH cohorts (29% vs 28%, p = 0.6). Further, 62% of people with TB (n = 124) experienced food insecurity during the treatment. To cope with rising costs 32% of affected households resorted to borrowing or selling assets (26%) to cushion the household against the increasing costs. Three (n = 3) participants reported interrupting schooling and seven (n = 7, 4%) reported experiences of social exclusion or isolation. Table 3 compares the incurrence of catastrophic costs and adverse socio-economic consequences by referring provider.

Table 3
Comparing the incurrence of catastrophic costs and socio- economic consequences by referring provider

Adverse consequence	Total (n = 195) N (%)	PPMV (n = 87, 44%) N (%)	TH (n = 108, 56%) N (%)	P value*
Catastrophic cost incurrence	52 (27)	25 (29)	27 (25)	0.6
Poverty headcount pre-TB	83 (43)	29 (33)	54 (50)	**< 0.01**
Poverty headcount post-TB	121 (62)	29 (33)	92 (85)	**< 0.01**
Food insecurity experienced	122 (62)	71 (82)	51 (47)	**< 0.01**
Borrowing to support TB costs	64 (33)	39 (45)	25 (23)	**< 0.01**
Sale of assets to support TB	53 (27)	39 (45)	14 (13)	**< 0.01**
Loss of employment	20 (10)	2 (2)	18 (17)	**< 0.01**
Experienced stigma	19 (10)	3 (3)	16 (15)	**< 0.01**
Limiting self-contact	59 (30)	25 (29)	34 (31)	0.2
*Test = Chi square / Fishers exact test as appropriate; significant differences highlighted in bold				

Participants referred by THs experienced significantly more severe social consequences compared to those referred by PPMVs, including loss of employment (17% vs 2%, p < 0.01) and experiencing stigma (15% vs 3%, p < 0.01). The poverty headcount increased particularly among the TH cohort (50% pre-TB vs 85% post-TB), while it remained unchanged in the PPMV cohort (33%). The PPMV cohort were significantly affected by dissaving including the sale of assets (46%) and borrowing (45%) to support household costs.

Household income trends during TB

While the overall household income showed a downward trend during treatment, there were significant differences experienced by the two cohorts (Fig. 1). First, people referred by PPMV had a significantly higher household income pre-TB (USD 120 vs 96, p = 0.02) and towards the end of treatment (USD 96 vs

56, p < 0.01). Second, the PPMV group experienced a significant recovery in the household income, almost achieving the pre-TB income levels by end of treatment. The downward trend in household income was consistent throughout treatment the TH cohort.

Figure 1: Household income trends by referring provider at three time points (pre-TB, mid treatment and end of treatment)

Factors associated with catastrophic cost incurrence

Supplemental Table 1 presents the factors associated with incurring catastrophic costs. After adjusting for age and sex, the pre-TB household income quintiles remained independently associated with catastrophic costs. Compared to the highest income quintile (Quintile 5), the likelihood of incurring catastrophic costs increased progressively across lower income quintiles, showing a significant dose-effect relationship particularly for Quintiles 1–3.

Equity analysis

A subpopulation analysis revealed that pre-TB household income significantly impacted the incurrence of catastrophic costs and impoverishment among TB affected households. There is a dose-response relationship between incurrence of catastrophic costs and decreasing pre-TB household income. Figure 2 illustrates the proportion of households that incurred catastrophic costs and the change in poverty levels by household income quintiles. People belonging to the lowest quintile (poorest) experienced the highest prevalence of catastrophic costs (76%). Those in the highest income quintile (richest) were more likely to experience impoverishment due to TB (40% increase).

Figure 2: Proportion of catastrophic cost incurrence and impoverishment by pre-TB household income quintiles

A deterministic sensitivity analysis shows an increase of catastrophic cost incurrence at 10% threshold (68% of households), which is reversed at 40% threshold (5% of households). This trend is similar when using the output approach to estimate the indirect costs, and again when using the WHO catastrophic health expenditure estimation methods. The methods and results are described in Supplementary material 2.

DISCUSSION

Key findings

Our findings confirm that TB affected households in Nigeria continue to face significant costs and social consequences. From the study, a TB episode cost US$187, and 27% of affected households incurred catastrophic costs. Initial care seeking from either type of informal provider, TH or PPMV, did not significantly impact the overall cost of seeking care or the likelihood of incurring catastrophic costs. However, there were notable differences in the sociodemographic profiles of the two cohorts, which were also reflected in the social consequences they experienced. The pre-TB household income was the single

most determining factor associated with the likelihood of incurring catastrophic costs and recovery from financial impacts experienced by the households.

The TB-related costs reported in this study in the Northeast are significantly lower than those estimated in the National Nigeria Patient Cost Survey (PCS), which found an average cost of US$450 per TB episode, with 69% of affected households experiencing catastrophic costs (20). A key factor that may explain the lower costs in this study is the geographical setting in Northeast region, where the cost of living is comparatively lower (22). Expenses for essentials such as food and transportation, which remain the primary drivers of out-of-pocket TB-related costs, are typically reduced and as a result, the overall TB-related expenses incurred by participants in our study were markedly lower. Notably, despite the cost differences, pre-TB household incomes were similar across the two groups (USD 121 in this study vs. USD 125 in the national PCS). Beyond geographic and economic factors, methodological differences may also explain the variation in reported costs. The national PCS used a cross-sectional design, capturing a snapshot of costs at a single point in time. In contrast, this study employed a longitudinal approach, following patients over time to capture cost data more comprehensively and with less recall bias (24). A deeper reflection on the methodology is included under methodological considerations below.

The costs in our study are comparable to cost of DSTB episode reported in high burden countries in the region including DRC (USD181), Kenya (USD 104) Tanzania(USD 166) and Uganda (USD 151) (32–35), but much lower than Ghana (USD 430)(36). Further, the estimation of households incurring catastrophic costs was less than half that reported in the Nigeria PCS, but comparable to those reported in Kenya at 26%, Thailand at 29% and Indonesia at 38% (34, 37–39). Smaller studies carried out in three Nigerian states between 2011–2013 estimated the total cost of a TB episode between USD 109 and USD 592, with 44% incurring catastrophic costs(40–42); however, the differences in tools and definitions used in these studies may limit comparability.

The distribution between the cost categories was rather similar with medical costs accounting for 37% of all costs, non-medical costs 31% and indirect costs 32% of all costs respectively. This is in contrast to the national study where non-medical and indirect costs dominated the expenditure at 44% and 47% respectively (20). People referred by the PPMV incurred significantly higher costs for the entire treatment episode which may be attributed to the higher capacity to pay for healthcare in this group as evidenced by the higher employment rates, significantly higher incomes prior to TB and higher capacity to absorb the shocks through sale of and/or borrowing (43, 44).

The bidirectional relationship between TB and household income

Household income before TB is also a major determinant of the financial impact of TB. Poorer households in the lowest income quintiles were disproportionately affected by catastrophic costs. In our study, the proportion of catastrophic costs was highest in the lowest income quintile (76%) compared to 3% in the highest income group. People who sought care from THs were already more vulnerable to start with as they had less income pre-TB. The disproportional burden of costs among the poorer households

is consistent with the PCS in Nigeria(20), and has also been described in other countries including Burkina Faso, Ghana, Kenya, Nepal, Thailand, Tanzania and Vietnam where the proportion of catastrophic costs was much higher in households in the lowest income quintiles (33, 34, 36–38, 45). Prioritizing the provision of social assistance and social protection coverage particularly for people who are in the lower household quintile could remove financial barriers to care and improve treatment adherence among those with TB and reduce vulnerability for developing the disease for those at risk (46).

The median household income decreased during TB treatment. However, the group referred by the PPMV showed a drastic recovery in their income towards the end of treatment, almost reaching the pre-TB income levels. This phenomenon has also been described in Vietnam, Philippines and Laos (27, 47, 48). This income recovery may be related to the type of employment that allows this group to resume work once they health status improved. On the other hand, those referred by the THs continue to have a declining income throughout the course of treatment. Moreover, they were more affected by job losses and loss of income, demonstrating the role of TB in perpetuating the medical poverty trap (49).

Household impoverishment and coping mechanisms

At baseline, 44% of affected households were living below the poverty threshold of (USD 1.9/day) which is higher than the national estimate of 33% (50). During TB illness, this proportion increased by 30%. The TH-referred group was particularly affected increasing from 52% to 86%. There were no changes experienced within the PPMV cohort, although one third still experienced impoverishment. The trend of falling to poverty was not consistent across the pre-TB income quintiles. While we didn't investigate this in the study, we infer here the role of family and community support including monetary and non-monetary donations to the very poor that complement the household income. This has been described elsewhere in India and Tanzania (51, 52). To cope with the rising costs, households resorted to borrowing (32%) and/or selling assets (26%), particularly among the PPMV cohort. While this complements the household income in the short term among those with disposable assets, it can lead to longer term household impoverishment (20). Interventions such as offering complementary nutritional support and facilitating access to other existing social protection programs could help protect people with TB from further impoverishment (46, 47).

Social consequences of TB

Beyond the financial implications, people with TB continue to face devastating social consequences including food insecurity, loss of income and impoverishment. Almost two-thirds of affected households (62%) reported challenges to getting adequate food which is higher than the national estimates of 45%, and the 41% documented in selected African countries (20, 32, 33). Nutrition support has been shown to improve treatment adherence (53) and better treatment outcomes for people with TB(54), highlighting the importance of strengthening food support programmes, particularly for populations already at risk of poverty and undernutrition (46, 55, 56).

Loss of employment was another important social consequence. In our study, 11% of people reported losing their jobs or means of income due to TB. Job loss could be associated to stigma and

discrimination within the communities and workplaces, with the conditions not allowing them to continue work during illness and treatment. Thirty nine percent (39%) of participants experienced stigma and 30% limited contact with others, suggesting that both community stigma and self-stigma continue to afflict people with TB, further contribute to social and economic vulnerability. Although relatively few participants reported social consequences such as school interruption (2%) or social exclusion (4%), these events may have important long-term implications for affected households. Similar impacts, including educational disruption, family strain and social exclusion, have been documented in other settings as broader consequences of TB beyond costs (40, 57).

Addressing these challenges requires a broader response beyond medical treatment. Social protection interventions can help offset TB-related costs, improve access to food and other essential needs and mitigate social consequences of TB, including stigma, social exclusion and marginalisation (46, 58, 59). Further research is needed to determine what level and design of social protection would be adequate, timely and sufficiently broad in coverage to effectively mitigate both economic and social consequences of TB.

In addition, the engagement of TB-affected people in community interventions, programme monitoring and governance can contribute to stigma reduction and strengthen patient-centred approaches to TB care(60). Further, there is a need to strengthen workplace policies so people with TB can maintain employment and safely resume their during or after treatment.

Methodological considerations

This study underscores the inadequacy of using catastrophic cost as a stand-alone indicator of financial hardship due to TB. While it captures extreme healthcare-related expenses, it overlooks broader socioeconomic effects such as impoverishment, food insecurity, harmful coping strategies, reduced social participation, and stigma. A more comprehensive approach such as the “Sustainable Livelihood Framework” captures the impact of TB on key household measures and emphasizes the importance of assessing both monetary and nonmonetary losses(61). Additionally, tracking household income trends provides a useful proxy for recovery in financial capacity (27, 47, 48). Such multidimensional approaches can fully capture the socioeconomic impact of TB and support the development of equitable, multisectoral interventions(25, 46, 61).

We used a prospective longitudinal design to reduce recall bias associated with self-reported data. Although more resource-intensive, this approach provides a more accurate picture of TB's economic burden by capturing data in real time(25, 48). Our study found lower costs and fewer cases of catastrophic spending compared to national cross-sectional surveys, similar to findings from Vietnam, where longitudinal studies on DS-TB and DR-TB also reported reduced costs (27, 62). However, more recent studies in the Philippines and Nepal, which directly compared longitudinal and cross-sectional approaches reported higher costs and social impacts with the longitudinal studies, highlighting the complexity of cost estimation methods (48, 63). These mixed findings underscore the need to refine WHO

cost survey methods either by improving cross-sectional tools or developing simpler longitudinal approaches.

Study Limitations

This study had several limitations. First, it was conducted in a specific intervention setting in Northeast Nigeria and included only people with TB referred by engaged informal providers and treated within the National TB Programme; therefore, findings may not be generalisable to other settings or to people with TB who remain undiagnosed or seek care outside the programme. Second, cost and income data were self-reported and may be subject to recall or reporting bias, although the longitudinal design likely reduced recall error compared with cross-sectional surveys. Third, the survey did not capture all coping strategies that households may adopt during TB illness, such as reducing the number of meals, spending household savings which may lead to longer-term consequences such as undernutrition and stunting, or deeper household impoverishment.

CONCLUSION

Our findings underscore the significant economic and social burden TB places on households in Northeast Nigeria, particularly among the poorest. Although average costs were lower than national estimates, over a quarter of households incurred catastrophic health expenses and nearly two-thirds experienced food insecurity. While engaging informal providers like traditional healers and patent medicine vendors can improve early referral and access to diagnosis, it does not eliminate the substantial economic and social hardships faced by affected families. To address these challenges, comprehensive social protection measures must be scaled up to complement medical treatment, especially for low-income households most vulnerable to income loss and long-term impoverishment. TB must be addressed not only as a health concern but as a broader socioeconomic issue, demanding a coordinated, multisectoral response to deliver more equitable and socially responsive solutions.

Declarations

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Authors' contributions

Conceptualization: Beatrice Kirubi, Suraj Kwami, Stephen John, Jacob Creswell.

Implementation: Suraj Kwami, Stephen John

Data curation: Beatrice Kirubi, Stephen John, Suraj Abdulkarim

Formal analysis: Beatrice Kirubi

Writing – original draft: Beatrice Kirubi, Jacob Creswell.

Writing – review & editing: Beatrice Kirubi, Stephen John, Suraj Abdulkarim, Rachel Forse, Tushar Garg, Md. Toufiq Rahman, Robert Stevens, Emperor Ubochioma, Jacob Creswell.

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Competing interests

BK, TG, MTR and JC work at the Stop TB Partnership Secretariat. They do not make

funding decisions but provide technical support to selected projects.

Availability of data and materials

The data that support the findings of this study can be made available upon request with the permission of the National TP Programme and the Ministry of health, Adamawa State.

Ethics approval and consent to participate

The study protocol for the intervention was reviewed and approved by the Adamawa State Research Ethical Committees in the Ministry of Health Adamawa (no. 2022069).

Patient and public involvement

Community representatives and TB survivors were involved throughout the study. In the early stages, they provided support in mapping informal providers and selecting which ones to engage though the intervention. Additionally, community and local officials identified the facilities where engaged informal providers referred their clients and these facilities were used to recruit participants. After the study was completed, SAK and SJ presented these discussions at local community health forums and later to the State and National TB program officials during their quarterly meetings.

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Figures

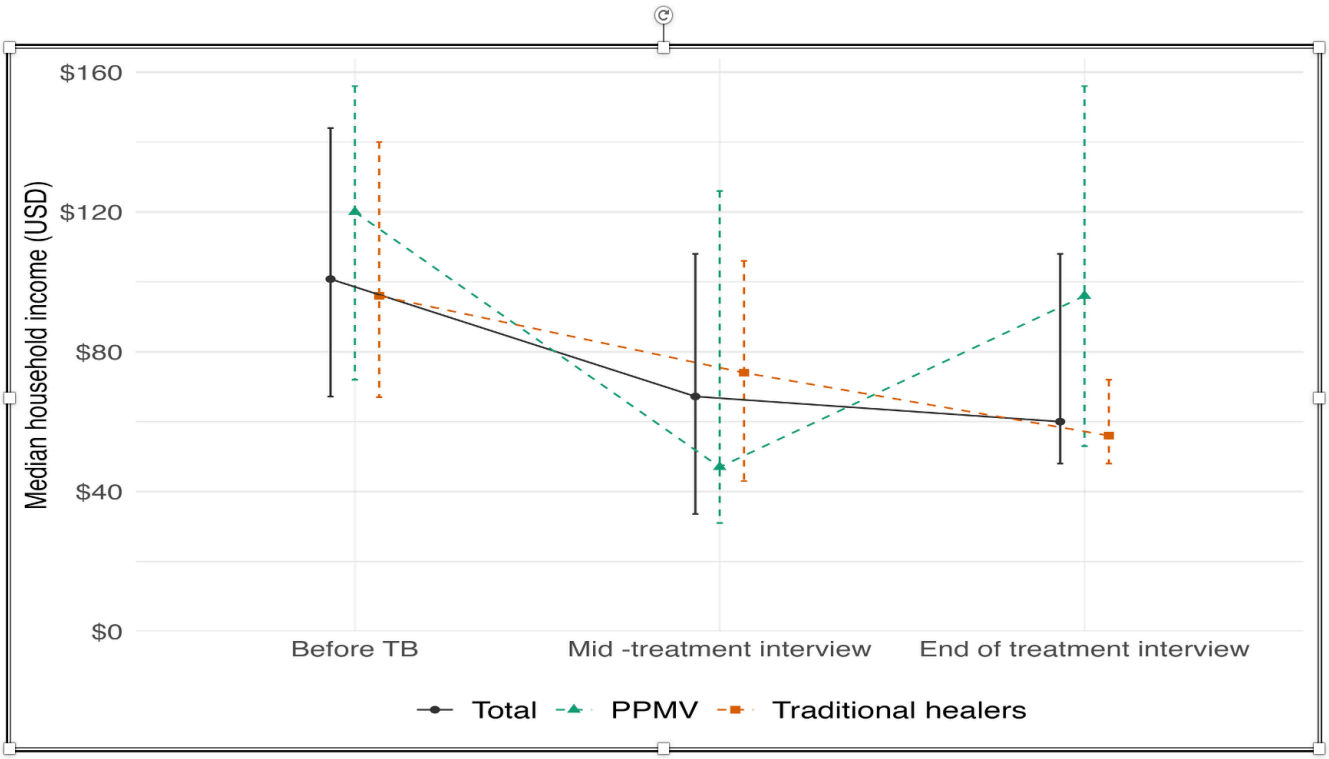


Figure 1: Household income trends by referring provider at three time points (pre-TB, mid treatment and at end of treatment)
PPMV= Patent and proprietary medicine vendors; USD= US Dollars

Figure 1

See image above for figure legend.

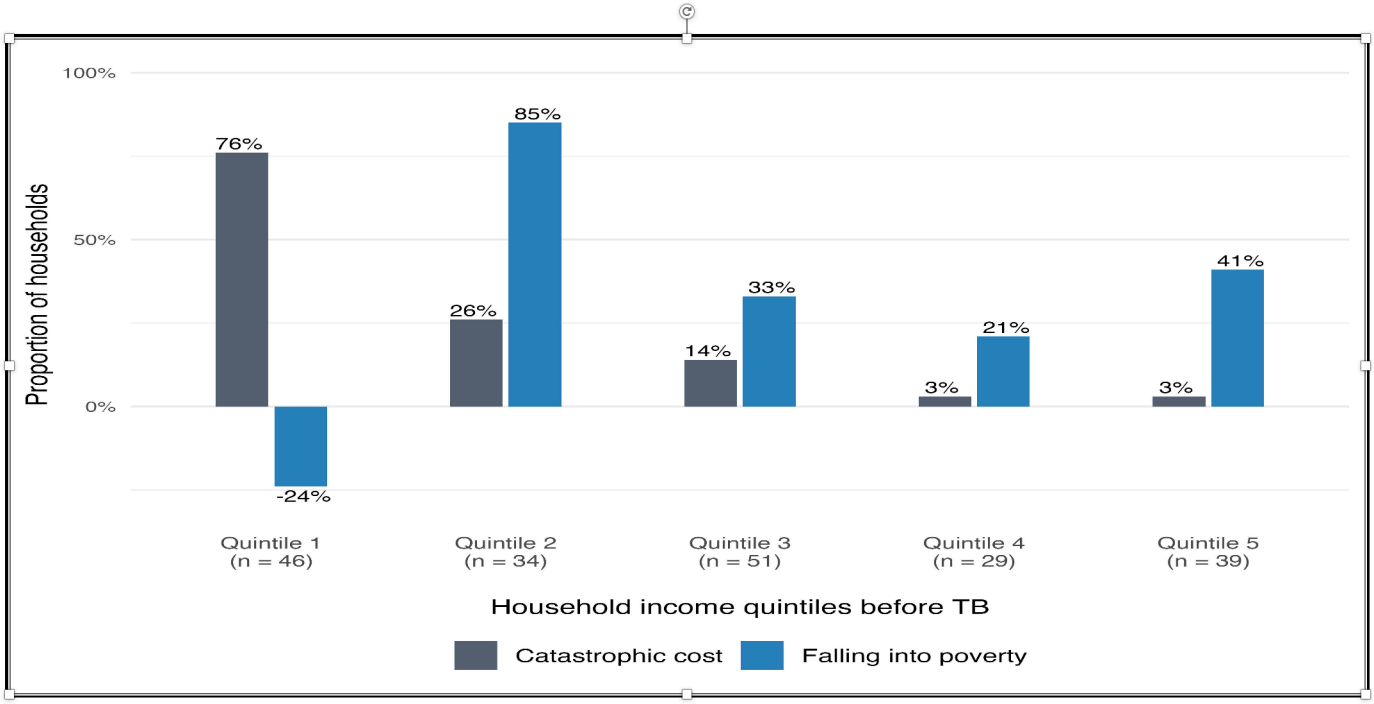


Figure 2

Proportion of catastrophic cost incurrence and impoverishment by pre-TB household income quintiles

Household income trends by referring provider at three time points (pre-TB, mid treatment and at end of treatment) PPMV= Patent and proprietary medicine vendors; USD= US Dollars

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Supplementalmaterial2sensitivityanalysis.docx
- SupplementalTable1.docx
- Supplementalmaterial1Adaptedquestionnaire.docx