

Predictors Of Catastrophic Costs of Tuberculosis (TB) Among Patients Co-Affected With TB-HIV And TB-Diabetes in Bhavnagar Region, Western India

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ABSTRACT

Background: By the year 2030, no family with a patient of tuberculosis (TB) is supposed to incur catastrophic costs. In India, a significant number of people suffer from TB, and many faces catastrophic costs. Our objective was to determine the predictors of catastrophic costs due to TB among co-prevalent TB-HIV and TB-diabetes patients.

Methods: We conducted a cross-sectional study among 234 patients co-affected with TB-HIV and 304 patients with TB-diabetes co-prevalence in the Bhavnagar region (western part of India). TB costs was estimated using a validated questionnaire. Multivariable logistic regression was used to determine the significant predictors of catastrophic costs of TB.

Results: Four percent of patients in each group incurred catastrophic costs due to TB. Female gender [aOR 6 (1.2-33)], being single [aOR 9 (1.5-52)], low socioeconomic status [aOR 7 (1.2-30)], private consultation for TB [aOR 9 (1.5-53)], and hospitalization in first HIV visit [aOR 19 (3-137)] were significantly predicted catastrophic costs of TB among patients co-affected with TB-HIV. Among patients with TB-diabetes co-prevalence, hospitalization in first TB visit [aOR 7 (2-29)], and private consultation for TB [aOR 7 (1.6-30)] were the significant predictors.

Conclusions: Despite a lower percentage of TB-HIV/ TB-diabetes patients facing catastrophic costs, hospitalization and private care-seeking are the “modifiable” determinants of TB catastrophic costs in our study setting.

Keywords: Tuberculosis-human immunodeficiency virus, Tuberculosis-diabetes, cost of illness, healthcare costs, tuberculosis elimination, national tuberculosis elimination program

INTRODUCTION

Tuberculosis (TB) is one of the diseases on the high-priority list for elimination globally by the year 2030. For many years, TB is a leading public health problem in India. India is said to be the country reporting the highest number of cases of TB worldwide.¹ As per the India TB Report, 1.9 million cases of TB were notified in the year 2021, 0.4 million higher than the estimates released by the World Health Organization

(WHO).^{1,2}

No TB-affected family should incur catastrophic costs - one of the targets for the elimination of TB - is to be achieved by the year 2030.³ WHO has defined costs due to TB exceeding 20% of annual household income as catastrophic.⁴ TB is a diverse disease and so is the prevalence of catastrophic costs incurred due to it in India.^{5,6} Globally, the prevalence of catastrophic costs among TB patients is 43% (95% CI

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34%-51%), due to drug-sensitive, drug-resistant, and HIV co-infection is 32%, 81%, and 81% respectively.⁷

Globally, various studies have documented the predictors of catastrophic costs incurred due to TB.⁶⁻²³ Among some recent studies, some of the predictors reported were private provider consultation for the initial visit⁶, hospitalization^{16,20}, loss of job¹⁷, human immunodeficiency virus (HIV) co-infection⁷, lower wealth quintiles^{18,20,23}, and drug-resistance.^{7,16,18,23} Evidence on predictors of catastrophic costs of TB among patients with TB-HIV co-infection or TB-diabetes comorbidity is lacking. We conducted this study to determine the predictors of catastrophic costs of TB among patients with TB-HIV co-infection and TB-diabetes comorbidity.

METHODS

Study design and setting: We conducted a cross-sectional study among patients with TB-HIV and TB-diabetes co-prevalence in the Bhavnagar region (western India). Bhavnagar city and district have a population of ~0.6 million and ~2.8 million respectively. The region is situated around 200 kilometres southwest of Ahmedabad city (the financial capital of Gujarat state in the western part of India). Bhavnagar reports approximately 2500 cases of TB every year. The care for patients with TB is largely decentralized, that is, patients need to make around 3-4 visits (for drug-sensitive pulmonary regimen) to a government health facility for diagnosis and follow-up. The medicines are placed nearby the homes of patients with a treatment supporter. TB health visitors pay home visits for examining the development of adverse drug reactions and provide supportive treatment for the same. Only in case of complications, do patients with TB need additional visits to health facilities.

Study population: We included 234 adult patients co-affected with TB-HIV infection and 304 adult patients with TB-diabetes co-prevalence notified during 2017-2020 in the Bhavnagar region under the public sector. We included all eligible patients meeting our inclusion criteria (universal sample) and none of the patients refused written informed consent to participate in our study.

Definitions:

Catastrophic costs: Costs were said to be catastrophic when total costs due to TB incurred by the patients exceeded 20% of the annual household income. We calculated the annual household income based on the self-reported total monthly family income at the time of the interview.

Standard of Living (SLI) index: SLI index was categorized into low vs. middle/ high SLI using a summary score calculated based on the possession of assets like the type of house, number of rooms, agricultural land, and others.⁶

Data collection, variables, and analysis: We used a

validated WHO questionnaire for calculating the catastrophic costs.⁴ Data on socio-demographic and other clinical variables were added to the questionnaire. The outcome variable was catastrophic costs incurred due to TB (dichotomous). We considered multiple variables like age, female gender, single (vs married), sputum smear grade, years of education, site of TB, TB drug sensitivity, tobacco smoking, SLI index, first consultation at a private provider, and hospitalization on the first visit as the predictors of catastrophic costs due to TB. Uni-variable logistic regression was performed to extract the variables to be included in the multivariable logistic regression. Predictors with a p-value ≤ 0.2 on univariable logistic regression were included in the multivariable model. Multivariable logistic regression was performed to determine the significant predictors (p-value < 0.05) of catastrophic costs of TB. Adjusted odds ratios (aOR with 95% confidence intervals CIs) were calculated using multivariable logistic regression.

Ethical considerations: The study was approved by the Ethics Committee of Government Medical College Bhavnagar. Written informed consent was obtained from all the study participants.

RESULTS

The prevalence of catastrophic costs among 234 patients co-affected with TB-HIV and 304 patients with comorbid with TB-diabetes was 4% each.

Predictors of catastrophic costs among TB-HIV

Among patients with TB-HIV co-infection, on univariable logistic regression, the variables - female gender, single (vs married), low SLI index, employed in paid work before TB, first TB consultation at a private provider, and hospitalization in first HIV visit - had a p-value of < 0.2 and were included in the multivariable logistic regression analysis (Table 1).

On multivariable logistic regression, female gender, single (vs. married), low (vs. middle/ high) SLI index, first TB consultation at a private clinic, and hospitalization in first HIV visit were the significant predictors of catastrophic costs of TB (Table 2). The female gender had 6 times (95% CI 1.2-33), being single had 9 times (95% CI 1.5-52), low SLI index had 7 times (95% CI 1.2-3), private consultation for the first TB visit had 9 times (95% CI 1.5-53), and hospitalization due to HIV in the first visit had 19 times (95% CI 3-137) higher odds of catastrophic costs due to TB as compared to their counterparts among patients co-affected with TB-HIV.

Predictors of catastrophic costs among TB-diabetes:

Among 304 patients co-affected with TB-diabetes, on univariable logistic regression, years of education, urban residence, first TB consultation at a private clinic, hospitalization in first TB visit, first diabetes consultation at a private clinic, and hospitalization in first diabetes clinic visit had a p-value of < 0.2 and were included in the multivariable logistic regression model (Table 3).

Table 1: Uni-variable logistic regression of predictors of catastrophic costs of tuberculosis (TB) among patients co-affected with TB-HIV during 2017-2020 in Bhavnagar (n=234)

Predictors	Unadjusted OR (95% CI)	P-value
Age (years)	1 (0.9-1.1)	0.564
Female gender	6 (1.6-21)	0.008
Single (vs. married)	3 (0.7-10)	0.155
Sputum smear grade	1 (1-1)	0.998
Years of education	0.9 (0.7-1.1)	0.229
Urban residence	1.3 (0.4-5)	0.671
Low (vs. middle/ high) SLI index	3 (0.8-11)	0.094
Employed in paid work before TB	0.4 (0.1-1.5)	0.165
Tobacco smoking	1.1 (0.3-4.5)	0.873
Extra-pulmonary TB	0.3 (0.03-2)	0.221
Drug-resistant TB	3 (0.3-27)	0.324
First TB consultation at private provider	4 (0.9-15)	0.054
Hospitalization in first TB visit	1 (1-1)	0.998
Unfavorable TB treatment outcomes	1.7 (0.4-7)	0.452
On anti-retroviral therapy (ART)	1 (1-1)	0.999
First HIV consultation at private provider	2 (0.6-8)	0.22
Hospitalization in first HIV visit	7 (1.6-30)	0.009

Table 2: Multivariable logistic regression of predictors of catastrophic costs of tuberculosis (TB) among patients co-affected with TB-HIV during 2017-2020 in Bhavnagar (n=234)

Predictors	Adjusted OR (95% CI)	P-value
Female gender	6 (1.2-33)	0.03
Single (vs. married)	9 (1.5-52)	0.016
Low (vs. middle/ high) SLI index	7 (1.2-30)	0.03
Employed in paid work before TB	0.7 (0.13-4)	0.67
First TB consultation at private provider	9 (1.5-53)	0.018
Hospitalization in first HIV visit	19 (3-137)	0.004

Omnibus test of model coefficients = 26 (p<0.05); Nagelkerke r² = 0.354; Hosmer-Lemeshow test p-value = 0.499; Classification accuracy = 96.2%

Table 3: Uni-variable logistic regression of predictors of catastrophic costs of tuberculosis (TB) among patients co-affected with TB-diabetes during 2017-2020 in Bhavnagar (n=304)

Predictors	Unadjusted OR (95% CI)	P-value
Age (years)	1.02 (0.9-1.1)	0.211
Male gender	0.9 (0.3-2.8)	0.796
Single (vs. married)	0 (0-0)	0.998
Sputum smears positive	1.2 (0.4-4)	0.77
Years of education	1.1 (1.01-1.2)	0.029
Scheduled caste/ scheduled tribe (SC/ST) caste	0 (0-0)	0.998
Urban residence	7.1 (0.9-55)	0.062
Extended (vs. nuclear) family	1.7 (0.2-13.8)	0.597
Low (vs. middle/ high) SLI index	0.6 (0.1-4.8)	0.639
Currently in paid work	0.4 (0.1-1.7)	0.208
Tobacco smoking	0.5 (0.1-2.6)	0.358
Current alcohol consumption	0 (0-0)	0.999
Previously affected with TB	1.9 (0.5-7.6)	0.31
Extra-pulmonary TB	1.5 (0.3-7.2)	0.594
Drug-resistant TB	0 (0-0)	0.999
First consultation for TB at private provider	7.9 (2.5-25.2)	<0.001
Hospitalization in first TB visit	12.3 (3.8-40.2)	<0.001
Unfavorable TB treatment outcomes	0 (0-0)	0.998
First consultation for diabetes at private provider	3.9 (1.1-13.3)	0.032
Hospitalization in first diabetes visit	4.6 (0.9-23.4)	0.064

Table 4: Multivariable logistic regression of predictors of catastrophic costs of tuberculosis (TB) among patients co-affected with TB-diabetes during 2017-2020 in Bhavnagar (n=304)

Predictors	Adjusted OR (95% CI)	P-value
Total years of education	1.1 (0.9-1.2)	0.067
Urban (vs. rural) residence	3.4 (0.4-29)	0.265
Hospitalization in first TB visit	7 (2-29)	0.008
First consultation for TB at private provider	7 (1.6-30)	0.01
Hospitalization in first diabetes visit	1.8 (0.3-11)	0.516
First consultation for diabetes at private provider	0.5 (0.1-3.2)	0.479

Omnibus test of model coefficients = 26 ($p < 0.05$); Nagelkerke $r^2 = 0.354$; Hosmer-Lemeshow test p -value = 0.499; Classification accuracy = 96.2%

On multivariable logistic regression, hospitalization at the first TB clinic visit, and first TB consultation at a private clinic were significant predictors of catastrophic costs of TB among patients with TB-diabetes co-prevalence (Table 4). Hospitalization in first TB clinic visit had 7 times (95% CI 2-29) and first TB consultation at a private clinic had 7 times (95% CI 1.6-30) higher odds of catastrophic costs of TB than their counterparts among patients with TB-diabetes co-occurrence.

DISCUSSION

To sum up, we found that female gender, being single, households with a low SLI index (low socioeconomic status), first TB consultation at a private clinic, and hospitalization in first HIV visit significantly predicted catastrophic costs of TB among patients co-affected with TB-HIV. Among patients with TB-diabetes co-prevalence, hospitalization in first TB visit, and first TB consultation at a private clinic were the significant predictors of catastrophic costs of TB.

Our study reported that hospitalization in the first visit due to HIV had 19 times (95% CI 3-137) higher odds of catastrophic costs among TB-HIV co-infected patients and hospitalization in the first TB visit had 7 times (95% CI 2-29) higher odds of catastrophic costs among TB-diabetes comorbid patients. Hospitalization was reported to be a significant predictor by investigators in other studies from Kenya, China, and Tanzania.^{15,16,20,21} Kirubi et al., Zhou et al., Yang et al., and Kilale et al. reported 3 times (95% CI 1.8-4.5), 3 times (95% CI 2.3-4.4), 6 times (95% CI 3.15-9.75), and 35 times (95% CI 12.5-146.2) higher odds of catastrophic costs of TB due to hospitalization respectively.^{15,16,20,21} However, hospitalization was found not significantly associated with total costs as well as costs for drug-resistant TB in studies from Indonesia and China.^{10,12} Patients lose wages and incur costs for transportation, food, and accommodation during the days of hospitalization. The costs escalate with an increase in the number of days of hospitalization and the number of accompanying members.

Among patients co-affected with TB-HIV and TB-diabetes in our study, the first TB consultation at a private clinic had 9 times (95% CI 1.5-53) and 7

times (95% CI 1.6-30) higher odds of catastrophic costs of TB respectively. Our study findings were supported by studies among patients with TB in Nigeria and Kenya - 3 times (95% CI 1.5-5.9) and 1.25 times (95% CI 1.1-1.7) - higher odds of TB catastrophic costs respectively.^{14,20} However, the type of facility was not a significant predictor in studies from Ghana and Indonesia.^{12,18} Nearly half of the patients with TB seek a private care provider for their care in India.²⁴ Patients incur significantly higher costs in the private sector than government providers, especially the direct medical costs.⁶ Thus, the chances of catastrophic costs among those visiting private practitioners are higher.

In our study, households with a low SLI index (low socioeconomic status) were compared with households with a middle/ high SLI index (middle/ high socioeconomic status). We established that households with a low SLI index had 7 times (95% CI 1.2-30) higher likelihood of facing catastrophic costs, similar to Yang et al. in China.²¹ Other investigators also reported that poor households were 4 times (95% CI 1.7-7.8) more likely in Indonesia¹², 16 times (95% CI 7.5-33.1) more likely in Zimbabwe¹⁹, 3 times (95% CI 1.3-6.7) more likely in urban Uganda²⁵, and 14 times (95% CI 1.5-126.5) more likely in China to incur catastrophic costs due to TB.²⁶ Catastrophic costs further push poor households below the poverty line, thereby increasing their financial burden.

Our study found female patients had 6 times (95% CI 1.2-33) higher odds of experiencing catastrophic costs due to TB among TB-HIV co-infected patients. However, a study in Nigeria found the male gender to be significantly associated¹⁴, whereas Zhou et al., Yang et al., Kirubi et al., and Pedrazzoli et al. found no associations between gender and catastrophic costs.^{15,18,20,21} Ukwaja et al. in their study in Nigeria found male patients being 3 times (95% CI 1.8-5.2) more likely to incur catastrophic costs due to TB. Being the primary earners in a family, we would expect the 'male gender' to be a significant predictor of catastrophic costs. However, women are the primary homemakers of a family and many of the household chores are handled by them. During the debilitating phases of the disease, families might have to incur costs for household chores such as cooking if the female member is affected with TB.

Similar to our study, where we found single people at 9 times (95% CI 1.5-52) higher odds, a study from China reported 'divorced/ widow' as 2 times (95% CI 1.1-4.5) more likely to incur catastrophic costs due to TB.¹⁰ On the other hand, studies from China and Cairo found no association between marital status and catastrophic costs.^{15,17} Those who are divorced or separated due to any reason might be incurring higher TB costs due to a lack of financial support from any other family member.

This is the first study determining predictors of catastrophic costs due to TB among patients co-affected with TB-HIV and TB-diabetes. The study findings can be generalized to similar semi-urban and rural settings in India.

CONCLUSIONS

We conclude that despite a lower percentage of TB-HIV/ TB-diabetes patients facing catastrophic costs, hospitalization and private care-seeking are the "modifiable" determinants of TB catastrophic costs in our study setting. Early detection, prompt treatment, outreach programs for awareness of free care in the government sector, referral of impoverished patients to the government sector by private doctors, and further expansion of the decentralized model of TB care might avert catastrophic costs due to TB in India.

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