

# Assessment of the Indirect Cost of Drug Resistant Tuberculosis Treatment to Patients in a High Burden, Low Income Setting in Mozambique

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## Abstract

**Introduction:** Tuberculosis is closely linked to poverty, with patients facing significant indirect treatment costs. Treating drug-resistant tuberculosis further increases these expenses. Notably, there is a lack of published data on the indirect costs incurred by patients with drug-resistant tuberculosis in Mozambique. **Objective:** To assess the indirect costs, income reduction, and work productivity incurred by patients undergoing diagnosis and treatment for Drug-Resistant Tuberculosis (DRTB) in Mozambique during their TB treatment. **Methods:** As part of a comprehensive mixed-methods study conducted from January 2021 to April 2023, this research utilized a descriptive cross-sectional approach, incorporating both quantitative and qualitative methods. The primary goal was to evaluate the costs incurred by the national health system due to drug-resistant TB. Additionally, to explore the indirect costs experienced by patients and their families during treatment, semi-structured interviews were conducted with 27 individuals who had been undergoing treatment for over six months. **Results:** All survey participants unanimously reported a significant decline in labour productivity, with 70.3% experiencing a reduction in their monthly income. Before falling ill, the majority of respondents (33.3%) earned up to \$76.92 monthly, representing the minimum earnings range, while 29.2% had a monthly income above \$230.77,

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the maximum earnings range. Among those who experienced income loss, the majority (22.2%) reported a decrease of up to \$76.92 per month, and 18.5% cited a loss exceeding \$230.77 per month. Notably, patients with Drug-Resistant Tuberculosis (DRTB) have not incurred the direct costs of the disease, as these are covered by the government. **Conclusion:** The financial burden of treating Drug-Resistant Tuberculosis (DRTB), along with the income reduction it causes, is substantial. Implementing a patient-centred, multidisciplinary, and multisector approach, coupled with strong psychosocial support, can significantly reduce the catastrophic costs DRTB patients incur.

## Keywords

Economic Costs, Drug Resistance, Tuberculosis, Catastrophic Costs

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## 1. Introduction

Tuberculosis (TB) remains a significant public health challenge, especially in low- and middle-income countries where it is most prevalent. In 2022, approximately 10.6 million people contracted TB, and 1.6 million died from the disease globally [1]. The emergence of drug resistance to first-line treatments has exacerbated the situation, leading to higher mortality rates and increased treatment costs. Drug-resistant tuberculosis (DRTB) is particularly challenging to treat, necessitating the use of more expensive and toxic medications. This not only complicates efforts to control the disease but also results in additional financial burdens for patients [2] [3].

Mozambique ranks among the top 10 countries with the highest burden of TB, TB/HIV, and drug-resistant TB (DRTB) globally, as per the WHO TB high burden list [4]. It is a Southern African nation where nearly half of its population is under 15 years old, two-thirds reside in rural areas, and about 62% live below the poverty line [5] [6] [7]. The country has a TB incidence of 361 per 100,000 people, with 98,000 new TB cases reported in 2022, 3.7% of which were DRTB. Despite TB treatment coverage being around 85%, the treatment success rate, especially for DRTB, remains below the WHO target at 72%. In 2022, 12% of TB patients in Mozambique died [1].

Poverty is a key factor in the spread of tuberculosis (TB), with the disease predominantly affecting countries and populations at the lower end of the poverty index. Studies have highlighted a symbiotic relationship between poverty and TB. Poverty contributes to the transmission of TB through malnutrition, limited access to healthcare, overcrowding, and poor living conditions, among other factors [8] [9]. Conversely, TB can worsen the economic status of those affected, undermining their physical wellbeing and productivity, and leading to loss of earnings. Additionally, patients may face costs related to treatment, transport, and other expenses associated with their illness [10] [11].

To address the impact of tuberculosis (TB) on patients' economic status, the

third EndTB strategy target aims to eliminate catastrophic costs associated with TB by 2035. Catastrophic cost is defined as a financial burden exceeding 20% of a household's income [3] [12]. To track progress towards the EndTB strategy goals, the World Health Organization (WHO) advises baseline and periodic assessments of the total catastrophic costs due to TB, through surveys that examine patient costs associated with TB. These surveys may estimate the proportion of patients facing catastrophic costs [12]. In 2022, the global TB report revealed that 48% of TB patients in 27 countries undergoing the national catastrophic cost survey experienced catastrophic costs due to TB. In Mozambique, the understanding of catastrophic costs incurred by TB patients is limited, as no comprehensive survey has been conducted [1]. To fill this knowledge gap, our study assessed the economic impact of TB treatment on patients diagnosed and treated for Drug-Resistant TB (DRTB), focusing on the indirect costs of income reduction and work productivity loss due to DRTB treatment, in the absence of specific catastrophic cost data for the country.

## 2. Materials and Methods

### 2.1. Study Design

This descriptive cross-sectional study was conducted from January 9th to April 30th, 2023. It included both quantitative and qualitative semi-structured interviews with patients undergoing DRTB treatment for more than six months. The goal was to evaluate the indirect costs borne by patients and their families during treatment. This evaluation was part of a larger study assessing the costs incurred by the Mozambican national health system for DRTB treatment, which took place from July 2021 to January 2023.

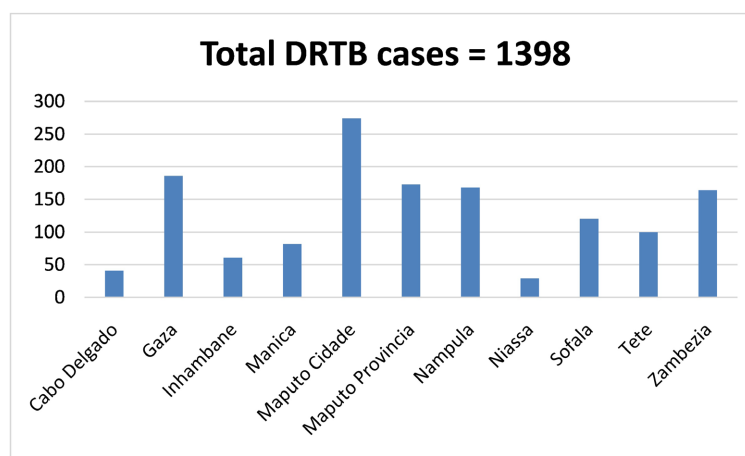
The assessment focused solely on the indirect costs from the perspective of patients and their families, excluding costs related to health facility operations or the national health system, such as administration, energy, water, and other support services.

### 2.2. Study Site and Population

The study included all health facilities in Maputo City, Mozambique, that had diagnosed and notified at least one case of drug-resistant tuberculosis (DRTB). We recruited patients who were diagnosed and had been receiving DRTB treatment for more than 6 months at each of these facilities.

Maputo City reports the highest rate of DRTB reports, accounting for about 20% of all DRTB cases in the country (Figure 1). The selection of Maputo's health facilities was based on their proximity, accessibility, and the consideration of study implementation costs.

There are 36 public health units in the city, a central hospital, a mental health hospital, four general hospitals, and 30 health clinics. As of 2019, 19 of these clinics had registered patients with DRTB (Table 1). About 3,210 medical professionals work in Maputo, of whom 720 are physicians (9 are pulmonologists) [13].



**Figure 1.** DRTB cases per province in Mozambique (2019).

**Table 1.** Number of DRTB cases registered per health centre in 2019.

| District     | Health clinic      | # of DRTB cases registered (2019) |
|--------------|--------------------|-----------------------------------|
| Kamavota     | CS 1 de Junho      | 6                                 |
| Kamaxakene   | CS 1 de Maio       | 25                                |
| Kamavota     | CS Albazine        | 4                                 |
| Kampfumo     | CS Alto Maé        | 63                                |
| Kamubukwana  | CS Bagamoio        | 26                                |
| Katembe      | CS Catembe         | 3                                 |
| Nlhamankulu  | CS Chamanculo      | 14                                |
| Kamavota     | CS Hulene          | 7                                 |
| Kamubukwana  | CS Inhagoia        | 3                                 |
| Nlhamankulu  | CS José Macamo     | 6                                 |
| Kamubukwana  | CS Magoanine       | 2                                 |
| Kamubukwana  | CS MagoanineTendas | 3                                 |
| Kampfumo     | CS Malhangalene    | 2                                 |
| Kamavota     | CS Mavalane        | 49                                |
| Kamavota     | CS Pescadores      | 4                                 |
| Kamaxakene   | CS PolanaCaniço    | 18                                |
| Kamavota     | CS Romão           | 3                                 |
| Nlhamankulu  | CS Xipamanine      | 30                                |
| Kamubukwana  | CS Zimpeto         | 6                                 |
| <b>Total</b> |                    | <b>274</b>                        |

### 2.3. Participant Selection

We randomly selected patients aged 18 years or older who had been on DRTB treatment for more than 6 months. We excluded patients with severe psychological disturbances that impaired their ability to understand the questions.

## 2.4. Sample Size

The sample size was determined by saturation, meaning that no new information was obtained after interviewing a certain number of respondents. In total, 27 patients undergoing DRTB treatment for more than 6 months were interviewed.

## 2.5. Procedure

Data was collected using a semi-structured interview guide specifically designed for this study (**Supplementary 1**). Interviews were conducted during DRTB patient care consultations, where individuals were asked for their consent to discuss treatment dynamics. The discussion focused on non-medical costs associated with the treatment, such as transportation, nutrition, loss of workdays, among others. Responses were recorded in individual notepads and compiled in an Excel<sup>®</sup> spreadsheet.

## 2.6. Data Management and Analysis

The data collected from the interviews were organized for systematic analysis and interpretation by creating categories of similar content. Initially, the interview contents were transcribed and read to systematize them. This was followed by coding, where contents were associated with specific themes, taking into account the recording units and context. Subsequently, categorization grouped similar topics for a summarized presentation of results. In essence, the content analysis as defined by Bardin (1977) was conducted [14]. This analysis identified several themes, including impacts on income due to illness, reduced productivity or inability to continue working, and dietary change needs.

## 2.7. Ethics Statement

Guidelines for Good Clinical Practice (GCP) and the principles of the Declaration of Helsinki were adhered to during the study. On December 8, 2022, the Institutional Ethics Committee (CIBS) of Beira approved study protocol version 2.0 and the written informed consent documents (Reference number 069/CIBS-Sofala/2022). Authorization was also granted by Maputo's Department of Health and Social Action and the Ministry of Health. No patient identifiers were included in the final analysis to maintain patient confidentiality and privacy.

## 3. Results

The study indicates that 59.3% ( $n = 16$ ) of the patients are male, and 40.7% ( $n = 11$ ) are female. The majority of respondents reside in Nlhamankulu, Kampfumo, and KaMavota districts, at 29.6% (8), 25.9% (7), and 22.2% (6), respectively. The age distribution shows most patients fall within the 29 - 48 years (59.3%;  $n = 16$ ) and 49 - 68 years (25.9%;  $n = 7$ ) ranges. Regarding education, 44.4% ( $n = 12$ ) completed secondary education, 33.0% ( $n = 9$ ) finished primary education, and 14.8% ( $n = 4$ ) attained higher education. The primary occupations were trades-

men (18.5%; n = 5), domestic workers (14.8%; n = 4), with the rest (29.6%; n = 8) belonging to various other professions. The sociodemographic profile of the patients is detailed in **Table 2**.

**Table 3** shows the disease's direct income impact and indirect costs, including lost income, reduced productivity, inability to work, and changes in patient diets.

Before the illness, most interviewees (33.3%; n = 9) had a monthly income of up to \$76.92, while 29.2% (n = 8) earned above \$230.77. The majority (70.3%; n = 19) reported income loss due to the disease, with 22.2% (n = 6) losing up to \$76.92. Additionally, 18.5% (n = 5) experienced losses exceeding \$230.77, the highest pre-illness income range.

The most significant indirect disease costs were from productivity loss and work incapacity. All respondents reported reduced or lost productivity, and 93.0% (n = 25) were unable to work. Only 7.0% (n = 2) cited dietary changes as an indirect cost.

Interviewees primarily attributed the indirect costs, including reduced or lost productivity and the inability to undertake physically demanding tasks or mobility difficulties, to functional limitations. Job loss and complete income forfeiture were also highlighted, as one patient recounted:

*"...at the beginning it was not easy, my whole body was in pain and I was coughing a lot, but I had to go work as I was the only breadwinner at home. I had to choose between staying in bed or going to work. I was a security guard in some house, until one day I was coughing a lot and my boss heard me, and sent me to the hospital. I went there and started treatment, at the start it got worse because the medication was too strong, in that month my boss paid me my salary and fired me."* (Samuel, 2023)

In the context of job loss and direct income, 93.0% (n = 25) of respondents unanimously reported stopping work within the first 4 to 6 months due to illness, while only 7.4% (n = 2) said they never interrupted their work due to fear of losing income, as stated by one of the interviewees:

*"There was no way I could stop selling, because my income is daily, if I stop one day it means I have no food that day. What I did was to continue selling at home with the help of my nephew in the first months, but afterwards I went back to the streets to increase the sales."* (Joana, 2023)

In an attempt to analyse the indirect costs related to diet, some patients claimed to have changed their diet, while others did not. Among those who did not change, some lacked the income to improve their diet, while others felt no need or lacked access to food. Unemployment and insufficient income were also cited as reasons for not altering their diet, as mentioned by one of the interviewees:

*"...even if I wanted to change or increase the food, without the illness it was already difficult to eat all daily meals, imagine without work."* (Salma, 2023)

Nutritious diets helped to aid recovery, according to a few interviewees who

**Table 2.** Sociodemographic profile of interviewed patients.

| Variables         | Categories     | Frequency | %    |
|-------------------|----------------|-----------|------|
| <b>Sex</b>        | Female         | 11        | 40.7 |
|                   | Male           | 16        | 59.3 |
| <b>Age</b>        | 18 - 28        | 3         | 11.1 |
|                   | 29 - 48        | 16        | 59.3 |
|                   | 49 - 68        | 7         | 25.9 |
|                   | 69 - 88        | 1         | 3.7  |
| <b>Residence</b>  | KaMavota       | 6         | 22.2 |
|                   | KaMaxaquene    | 1         | 3.7  |
|                   | KaMfumo        | 7         | 25.9 |
|                   | KaMubukwana    | 4         | 14.8 |
|                   | KaTembe        | 1         | 3.7  |
|                   | Nlhamankulu    | 8         | 29.6 |
| <b>Education</b>  | Graduate       | 4         | 14.8 |
|                   | Other          | 2         | 7.4  |
|                   | Primary        | 9         | 33.3 |
|                   | Secondary      | 12        | 44.4 |
| <b>Profession</b> | Other          | 8         | 29.6 |
|                   | Tradesman      | 5         | 18.5 |
|                   | Domestic       | 4         | 14.8 |
|                   | Security guard | 2         | 7.4  |
|                   | Miner          | 2         | 7.4  |
|                   | Retired        | 3         | 11.1 |

**Table 3.** Income and indirect costs of DRTB treatment.

| Variables                            | Income* (\$)     | Frequency | %    |
|--------------------------------------|------------------|-----------|------|
| <b>Monthly income before illness</b> | Up to 76.92      | 9         | 33.3 |
|                                      | 76.94 - 153.85   | 4         | 14.8 |
|                                      | 153.86 - 230.77  | 6         | 22.2 |
|                                      | More than 230.77 | 8         | 29.6 |
| <b>Loss of income due to illness</b> | Up to 76.92      | 6         | 22.2 |
|                                      | 76.94 - 153.85   | 3         | 11.1 |
|                                      | 153.86 - 230.77  | 5         | 18.5 |
|                                      | More than 230.77 | 5         | 18.5 |
| <b>Loss/low productivity</b>         | None             | 8         | 29.6 |
|                                      | Yes              | 27        | 100  |
| <b>Inability to work</b>             | No               | 2         | 7.4  |
|                                      | Yes              | 25        | 92.6 |
| <b>Changes in nutrition</b>          | Yes              | 2         | 7.4  |
|                                      | No               | 25        | 92.6 |

\*Used the exchange rate in 2019 which was \$1 = 65 Mts (Banco de Moçambique, 2019) (\$ = United States Dollar; Mts = Meticaís).

managed to change their diet following medical recommendations. As one interviewee reported:

*“I followed the recommendations of the nurse, I added bananas, eggs and fish to the diet to be able to tolerate the medications.” (Salma, 2023)*

One of the indirect costs significantly impacting patients is transportation costs. However, this study did not analyse this factor because the Government of Mozambique has implemented a pilot transport subsidy strategy for patients with DRTB, providing a monthly subsidy of \$8.31. Participants in this study reported benefiting from this subsidy.

Patients with DRTB have not personally incurred the direct costs of the disease, as all interviewees confirmed they do not purchase medications or pay for clinical exams outside health facilities. These costs are fully covered by the government.

#### 4. Discussion

Regarding monthly income, 33.3% of patients earned below Mozambique’s basic wage of \$134.74 per month [15], 14.8% earned around the basic wage, and 29.6% earned double the basic wage or more. Although tuberculosis (TB) is associated with socioeconomic vulnerability and diagnostic workup and treatments are provided by the public health system, patients and their families bear the indirect costs. Previous studies have shown that direct and indirect costs lead to a 1% - 20% loss of family income, and seeking a tuberculosis diagnosis significantly burdens patients and their families [16] [17].

Of the total patients interviewed, 70.4% reported losing all or a significant portion of their monthly income, while only 29.6% said they had not lost any income due to having stable employment with social security benefits. This aligns with findings from other African studies, where over half of the patients experienced job loss due to the disease [11] [18] [19]. Regarding the indirect cost of diet, 92.6% of patients did not change their diets due to financial constraints and lack of appetite, with only 7.4% following dietary recommendations from clinicians. No patient reported receiving nutritional support, despite its recommendation to counteract the disease’s wasting effects and the side effects of treatment [16] [20]. Similar studies have also highlighted food insecurity as a major concern for TB patients [11] [19].

Concerning the direct costs of medication, laboratory analysis, and clinical exams, patients incurred no costs because healthcare in the public sector is free, consistent with findings from other studies where patients only incurred costs related to transport, time, and nutrition [21] [22]. However, in a recent development in Mozambique, patients in this study did not incur any indirect costs related to transport, as the state is implementing a pilot strategy to subsidize the transport of DRTB patients by \$8.31.

Rising costs for basic needs contribute to the DRTB burden. In a study by Arante (2019), which analysed the consumer price index and data from the



2014/15 Household Budget Survey, the Government of Mozambique estimates that the cost of a basic food basket increased by 55% to 70% between 2014 and 2016. This increase is reflected in the national poverty rate, which is estimated to have risen by 55% to 60% in subsequent years [23]. Consequently, the subsidy provided may not suffice to cover the basic needs of patients undergoing treatment for DRTB, particularly regarding food, although it offers significant relief, especially to those who have lost income. Despite relatively low direct costs, these minor expenses can be catastrophic for many patients, as a significant number have no income [24].

The study clearly shows that TB disease significantly undermines patients and their families economically, especially those with lower incomes. A high percentage of patients suffer from income loss, emphasizing the need for comprehensive support mechanisms to alleviate the financial strain caused by the disease [25] [26]. Moreover, the lack of nutritional support for most patients exposes a critical deficiency in the current healthcare system, given that proper nutrition is crucial for effective TB treatment [27] [28] [29]. While the transport subsidy for DRTB patients is a positive development, more focused interventions are necessary to tackle the complex socioeconomic challenges TB patients face in Mozambique.

Since the state covers the direct costs of medication and clinical exams in the public sector, patients primarily bear the financial burden of indirect costs like transportation, time, and nutrition. This highlights the need for comprehensive health systems that offer free or low-cost treatment and tackle the indirect costs preventing patient access to care [30] [31]. Implementing policies to mitigate these indirect costs, such as transport subsidies, can significantly enhance treatment adherence and outcomes for TB patients and lessen the economic impact on affected individuals and communities.

### Limitations

Limitations of this study include its exclusive focus on income reduction and work productivity, due to limited data availability. It did not consider other dimensions of indirect costs, such as emotional distress, social isolation, caregiver burden, nutritional support, and long-term socioeconomic impacts on families. Future research should expand the assessment of indirect costs to better understand the catastrophic impact of DR TB on patients in Mozambique. Nevertheless, as the first study of its kind in Mozambique, it offers valuable insights for policy-makers on the challenges faced by patients undergoing DR TB treatment.

The cost of treating DRTB is seldom addressed in studies, particularly in Mozambique. Future research should concentrate on the catastrophic expenses related to drug-sensitive TB, inpatient treatment of DRTB, and TB-associated opportunistic diseases, as well as the coping mechanisms employed. Since the interviews were self-reported, there is a potential for bias in the responses, as patients might not recall specific details or might respond in a manner they believe is acceptable. To minimize this bias, study investigators should ask follow-up or

clarification questions.

## 5. Conclusion

Although the government offers free medicines and treatment, the significant financial impact of income loss due to DRTB is considerable for both patients and their families. To address these potential catastrophic costs, a patient-centred, multidisciplinary, multisector approach with strong psychosocial support is crucial. Recognizing that national TB programs may not achieve the goal of zero TB-driven catastrophic costs by 2035, a comprehensive strategy is essential.

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## Availability of Data and Materials

All datasets and materials of the study are available.

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## Authors Contribution

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- Investigation: Júlia Malache António, Pereira Zindoga.
- Project administration, resources, supervision: Domingas Pacala, Benedita José, Claudia Mutaquiha.
- Data curation: Júlia Malache António, Isaiás Benzana.
- Formal analysis: Júlia Malache António, Pereira Zindoga, Isaiás Benzana, Domingas Pacala.
- Validation and visualization: Júlia Malache António, Isaiás Benzana.
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All authors read and approved the final version of the manuscript.

## Conflicts of Interest

The authors have no conflict of interest to declare.

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## Supporting Information

### Supplementary 1: Interview form

#### Annex 1

#### Interview Form for drug resistant Tuberculosis patients

Health Facility \_\_\_\_\_

#### Questionnaire

The present questionnaire was designed within the framework of the development of a study on the costs of treating MDR-TB in patients treated at Health Units in the City of Maputo. Its content is exclusively for academic purposes, so any and all information provided will be properly treated, protecting the identity of the informant.

Questionnaire N°: \_\_\_\_ Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

#### I. IDENTIFICATION

Sex F ( ) M ( ) Age: \_\_\_\_ (years)

Education: Primary ( ) Secondary ( ) Bachelor ( ) Masters ( ) Other ( )

Profession: \_\_\_\_\_

Monthly income in Meticals: up to 5000 ( ) 5001 up to 10,000 ( ) 10,001 up to 15000 ( ) +15,000 ( )

Residential address: \_\_\_\_\_

Household number \_\_\_\_ members of the group

#### II. QUESTIONNAIRE

1. How do you travel to the HF? ( ) Private car transport ( ) Public car transport ( ) Motorbike ( ) Bicycle ( ) Walking ( ) Other: \_\_\_\_\_

1.1. Was there transportation expense? ( ) Yes ( ) No. If yes, how much? \_\_\_\_\_

2. During illness was there a need for different or extra food? ( ) Yes ( ) No

3. Did you have to buy other medications other than those given by the HF? ( ) Yes ( ) No

3.1. If yes, how much did you spend? \_\_\_\_\_

4. Were there any costs for medical tests? Yes ( ) No ( ) Which ones? \_\_\_\_\_

4.1. If yes, how much did you spend? \_\_\_\_\_

5. Did you stop working due to the illness? ( ) Yes ( ) No

5.1. If yes, how much did you lose in salary/earnings? \_\_\_\_\_

5.2. If no, was there any loss of productivity ( ) Yes ( ) No

5.3. How much did you lose? \_\_\_\_\_

6. Do you get any help from the government? ( ) Yes ( ) No

6.1. Which? ( ) INSS (social security) benefit ( ) others \_\_\_\_\_

6.2. How much do you receive? \_\_\_\_\_