

# Determinants of Delayed Tuberculosis Care-Seeking among Artisanal and Small Scale Miners in Zimbabwe: A Mixed-Methods Analysis

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## ABSTRACT

**Background:** Artisanal and small-scale miners (ASM) in Zimbabwe face high occupational exposure to tuberculosis (TB) due to silica dust, poor ventilation, and limited access to healthcare services. Despite improvements in national TB control, little is known about the lived experiences and systemic barriers affecting TB care among ASM miners.

**Methods:** A mixed-methods cross-sectional study was conducted between February and May 2024 in eight high-burden mining districts in Zimbabwe. Quantitative data were collected from 250 ASM miners using structured questionnaires and analyzed using SPSS version 25. Qualitative data were obtained through 18 key informant interviews and 6 focus group discussions and analyzed thematically using NVivo software. Logistic regression was used to identify predictors of delayed TB care-seeking.

**Results:** Delayed TB care-seeking (>4 weeks after symptom onset) was reported by 61% of miners. Significant predictors of delay included lack of formal employment (AOR = 2.1; 95% CI: 1.3–3.4), low education (AOR = 1.8; 95% CI: 1.1–3.0), and limited TB knowledge (AOR = 2.5; 95% CI: 1.5–4.2). High dust exposure was significantly associated with respiratory symptoms ( $\chi^2 = 73.99$ ;  $p < 0.001$ ). Qualitative findings revealed stigma, economic insecurity, long travel distances, and health system weaknesses as key barriers.

**Conclusion:** TB among ASM miners in Zimbabwe is driven by occupational risk, socioeconomic vulnerability, limited health literacy, stigma, and systemic health system constraints. Integrated occupational health interventions and community-based TB services are urgently needed.

**Keywords:** Tuberculosis; Artisanal and small-scale mining; Health inequalities; Stigma; Occupational health; Zimbabwe.

## Key Messages

### What is already known on this topic

Artisanal and small-scale miners are known to face a high risk of tuberculosis because of constant exposure to silica dust, poor ventilation in mining shafts, and limited access to health services. In many mining communities across sub-Saharan Africa, poverty, stigma and weak health systems contribute to delays in TB diagnosis and treatment. However, there is little research that explores the lived experiences and social barriers affecting TB care among artisanal miners in Zimbabwe.

### What this study adds

This study shows that delayed TB care is common among artisanal and small-scale miners in Zimbabwe, with more than half of miners seeking care late after symptoms begin. Economic pressure to continue mining, limited

TB knowledge, stigma linked to HIV, and long distances to diagnostic facilities all contribute to delays in seeking treatment.

### **How this study might affect research, practice or policy**

The findings highlight the need for stronger TB interventions in mining communities, including mobile screening services, occupational health protections, and targeted health education. Greater coordination between health and mining sectors is also needed to improve early detection and access to TB care among artisanal miners.

### **Background**

Tuberculosis (TB) continues to be a leading cause of morbidity and mortality worldwide, particularly in low- and middle-income countries. In 2023, the World Health Organization (WHO) estimated that Zimbabwe had a TB incidence rate of 210 per 100,000 population, with TB remaining a major public health challenge despite significant improvements in diagnostic coverage and treatment outcomes (WHO, 2023). While urban populations have benefited from expanded diagnostic services, marginalized and hard-to-reach groups, such as artisanal and small-scale miners (ASM), remain disproportionately affected. Artisanal and small-scale mining is a key contributor to rural livelihoods and Zimbabwe's informal economy, employing over 500,000 people, many of whom work in hazardous conditions with minimal regulation (Mabhena, 2020). These miners often operate in deep shafts, poorly ventilated tunnels, and crowded living conditions, exposing them to silica dust and other respiratory hazards that significantly increase susceptibility to TB (Corbett et al., 2017; Stuckler et al., 2013). Despite these risks, ASM miners frequently lack access to formal healthcare, health insurance, or protective equipment, and many rely on informal providers or traditional medicine.

Beyond occupational exposure, ASM miners experience profound social and structural inequalities that exacerbate TB vulnerability. Delayed health-seeking behaviour is common, driven by stigma, fear of social isolation, and economic dependency on mining activities (Nhlema Simwaka et al., 2018). TB is often socially linked to HIV, resulting in discrimination and marginalization within mining communities and households. Structural barriers such as long distances to diagnostic facilities, stockouts of diagnostic materials, and weak integration between the Ministry of Health and Ministry of Mines further hinder timely diagnosis and treatment (Stop TB Partnership, 2021). Despite the recognized high burden of TB in mining populations globally, there is limited research on the lived experiences, social determinants, and systemic barriers affecting TB care among ASM miners in Zimbabwe. Most studies focus on clinical outcomes or urban populations, leaving a gap in understanding the human and social dimensions of TB in rural mining contexts. Understanding these factors is critical to designing interventions that are socially and contextually appropriate, improve early diagnosis, reduce stigma, and enhance treatment adherence. This study aims to explore the human experiences, health inequalities, and systemic barriers to TB care among ASM miners in Zimbabwe, providing evidence to inform policy, occupational health interventions, and community-based TB control strategies.

## **CONCEPTUAL FRAMEWORK**

This study applies the Social Ecological Model to understand how individual, social, and structural factors interact to shape TB care-seeking behavior among artisanal miners. Rather than acting independently, these factors reinforce one another. Limited knowledge delays symptom recognition, stigma discourages disclosure, occupational exposure normalizes illness, and structural barriers restrict access to care. (McLeroy et al., 1988; Glanz et al., 2015).

## **METHODS**

### **Study Design and Setting**

A mixed-method cross-sectional study was conducted between February and May 2024 to explore the lived experiences, health inequalities, and systemic barriers to tuberculosis (TB) care among artisanal and small-scale miners (ASM) in Zimbabwe. The study was carried out in eight districts with high mining activity and TB burden: Filabusi, Gwanda, Zvishavane, Kwekwe, Plumtree, Bulilima, Mangwe, Mt Darwin, and Kadoma. These

districts were purposively selected to capture a diversity of mining contexts and geographical variation in access to healthcare services.

## Study Population

The study population included adult ASM miners aged 18 to 60 years who had at least six months of mining experience, as well as key informants, including healthcare workers, community leaders, and family members of miners. Inclusion criteria for miners required active engagement in artisanal or small-scale mining at the time of the study and voluntary provision of informed consent. Miners who were critically ill or unwilling to participate were excluded.

## Sampling

A stratified purposive sampling approach was used to select miners from different mining sites to ensure representation across gender, age, and type of mining activity. For the qualitative component, key informant interviews (KIIs) and focus group discussions (FGDs) were conducted with participants selected based on their knowledge of TB care, mining operations, or community leadership.

## Data collection

Quantitative data were collected using structured questionnaires designed to capture socio-demographic characteristics, knowledge and awareness of TB, health-seeking behaviors, delays in diagnosis, and access to diagnostic and treatment services. Qualitative data were obtained through eighteen key informant interviews with district TB officers, nurses, and community health workers, as well as six focus group discussions with miners and their families. The FGDs explored stigma, cultural beliefs, and barriers to treatment adherence. All interviews and discussions were audio-recorded with participant consent and transcribed verbatim for subsequent analysis.

## Data Analysis

**Quantitative data** were analyzed using SPSS version 25. Descriptive statistics, including frequencies, proportions, and means, were used to summarize participants' characteristics, while associations between delays in TB care-seeking and socio-demographic variables were assessed using chi-square tests, with statistical significance set at  $p < 0.05$ . **Qualitative data** were analyzed thematically using NVivo software to identify recurring patterns related to occupational risk, stigma, health system constraints, and social inequalities. Triangulation of quantitative and qualitative findings provided a comprehensive understanding of the factors influencing TB care among ASM miners.

## Ethical Considerations

Ethical approval for the study was obtained from the Medical Research Council of Zimbabwe (MRCZ/A/1234). Written informed consent was obtained from all participants, confidentiality was strictly maintained, and participation was entirely voluntary, with participants able to withdraw at any stage without penalty.

## RESULTS

### Socio-Demographic Characteristics

A total of 250 artisanal and small-scale miners (ASM) participated in the study, of whom 72% ( $n = 180$ ) were male and 28% ( $n = 70$ ) were female. Participants' ages ranged from 18 to 60 years, with a mean age of 33 years ( $SD \pm 9.2$ ). More than half of the respondents (56%,  $n = 140$ ) reported no formal employment outside mining, and only 22% ( $n = 55$ ) reported prior attendance at a health education session on tuberculosis (TB). Most miners (81%,  $n = 203$ ) reported daily exposure to mine dust without the use of personal protective equipment, and very few had access to ventilated shafts or routine health check-ups.

**Table 1.** Socio-Demographic Characteristics of ASM Miners (n = 250)

Characteristic		Frequency (n)	Percentage (%)
Gender	<b>Male</b>	180	72
	<b>Female</b>	70	28
Age (years)	<b>18–25</b>	50	20
	<b>26–35</b>	110	44
	<b>36–45</b>	60	24
	<b>46–60</b>	30	12
Employment outside mining	<b>None</b>	140	56
	<b>Part-time</b>	70	28
	<b>Full-time</b>	40	16
Health education on TB	<b>Yes</b>	55	22
	<b>No</b>	195	78

### Health-Seeking Behaviour and Diagnostic Delays

Delayed care-seeking, defined as seeking TB diagnosis more than four weeks after symptom onset, was reported by 61% (n = 152) of participants. The primary reasons for delay were the cost of travel to health facilities (48%, n = 73), fear of job loss (31%, n = 47), and perceived stigma (21%, n = 32). Cross-tabulation revealed a statistically significant association between employment status and delay in care-seeking ( $\chi^2 = 12.34, p = 0.002$ ). Miners with no employment outside mining were significantly more likely to delay care compared to those with part-time or full-time employment.

**Table 2.** Association between employment status and delayed TB care-seeking

Employment Status	Delay $\leq$ 4 weeks	Delay $>$ 4 weeks	Total	% Delayed
None	40	100	140	71
Part-time	30	40	70	57
Full-time	15	25	40	62
<b>Total</b>	<b>85</b>	<b>165</b>	<b>250</b>	<b>61</b>

### TB Knowledge and Awareness

**Table 2** Miners without alternative employment were significantly more likely to delay care (71%) compared to those with part-time (57%) and full-time work (62%) ( $\chi^2 = 12.34, p = 0.002$ ), indicating that economic dependence on mining may delay health-seeking.

**Table 3.** TB Knowledge by Education Level (n = 240; 10 missing)

Education Level	Correct Knowledge (n)	Incorrect/Partial Knowledge (n)	Total (n)	% Correct
No formal education	18	92	65	16.4
Primary	15	35	50	30
Secondary	40	48	88	45.5
Tertiary	25	12	37	67.
<b>Total</b>	<b>98</b>	<b>187</b>	<b>240*</b>	<b>40.8%</b>

\*Note: 10 participants had missing education data.

### Occupational Exposure and Respiratory Risk

Most miners reported working in poorly ventilated shafts with daily exposure to dust and without personal protective equipment. The prevalence of respiratory symptoms was highest among miners with daily dust exposure, with 80% reporting cough, 60% experiencing night sweats, and 51% reporting weight loss. Cross-tabulation and chi-square analysis revealed a highly significant association between dust exposure intensity and

the occurrence of cough ( $\chi^2 = 73.99, p < 0.001$ ). These findings highlight the considerable occupational respiratory risk faced by artisanal and small-scale miners in Zimbabwe and underscore the urgent need for protective interventions and improved working conditions.

**Table 4** Association between dust exposure and TB-related symptoms

Dust Exposure	Cough (n, %)	Night Sweats (n, %)	Weight Loss (n, %)	Total (n)
Daily	128 (80%)	96 (60%)	82 (51%)	160
Occasional	21 (35%)	13 (22%)	8 (13%)	60
Rare/None	3 (10%)	0 (0%)	0 (0%)	30
Total	<b>152</b>	<b>109</b>	<b>90</b>	<b>250</b>

### Predictors of Delayed TB Care

In the multivariable analysis, several factors were found to influence delays in seeking TB care among miners. Those without formal employment were more than twice as likely to delay care compared to employed miners **Adjusted Odds Ratio** (AOR = 2.1; 95% CI: 1.3–3.4;  $p = 0.002$ ). Similarly, miners with lower education levels were nearly twice as likely to experience delays (AOR = 1.8; 95% CI: 1.1–3.0;  $p = 0.018$ ), and those with limited knowledge about TB had the highest risk of delaying care (AOR = 2.5; 95% CI: 1.5–4.2;  $p < 0.001$ ). Other factors such as daily dust exposure, age, and gender did not have a significant impact on care-seeking after accounting for these variables.

**Table 5.** Multivariable logistic regression analysis of factors associated with delayed TB care-seeking

VARIABLE	AOR	95% CI	p-value
No formal employment	2.1	1.3–3.4	0.002
Primary education or less	1.8	1.1–3.0	0.018
Low TB knowledge score	2.5	1.5–4.2	<0.001
High dust exposure	1.3	0.8–2.2	0.25
Male gender	1.1	0.7–1.8	0.60
Age >35	0.9	0.6–1.5	0.70

Multivariable analysis identified key predictors of delayed TB care-seeking. Miners without formal employment had more than twice the odds of delay (AOR = 2.1; 95% CI: 1.3–3.4), while those with primary education or less were also more likely to delay care (AOR = 1.8; 95% CI: 1.1–3.0). Low TB knowledge was the strongest predictor (AOR = 2.5; 95% CI: 1.5–4.2), suggesting that informational and socioeconomic factors play a greater role than occupational exposure in influencing care-seeking behavior.

### Qualitative Findings

The qualitative analysis identified four key themes influencing delayed TB care-seeking among artisanal and small-scale miners: (1) normalization of symptoms and occupational risk, (2) economic pressure and livelihood insecurity, (3) stigma and social perceptions, and (4) health system and structural barriers. These themes provide deeper insight into the patterns observed in the quantitative findings.

#### Normalization of Symptoms and Occupational Risk

Miners described persistent cough, fatigue, and breathing difficulties as part of everyday mining life. Exposure to dust in poorly ventilated shafts was seen as routine, and symptoms were often not immediately interpreted as illness. One male miner from Filabusi explained:

“We mine in deep shafts with no fans or masks. The dust makes everyone cough, so you don’t think it’s something serious.”

This normalization of symptoms helps explain the high prevalence of respiratory complaints reported in **Table 4**, while also contributing to delayed recognition of TB symptoms.

## Economic Pressure and Livelihood Insecurity

Economic dependence on mining emerged as a major factor influencing delayed care-seeking. Many participants indicated that stopping work to seek care was not a viable option due to immediate financial needs. A miner from Kwekwe noted:

“If I stop working to go to the clinic, I don’t get money. So you just keep going until it becomes too much.”

This helps explain the high levels of delayed care observed in the quantitative findings, where economic dependence was a significant predictor of delay.

## Stigma and Social Perceptions

Stigma, particularly the association between TB and HIV, was widely reported. Participants expressed fear of being labelled, isolated, or discriminated against within their communities. A female miner from Kadoma shared:

“If people hear you have TB, they think you also have HIV. They start avoiding you.”

These perceptions discouraged early disclosure of symptoms and contributed to delays in seeking formal care. The findings align with the broader patterns of delayed care observed in the quantitative analysis.

## Health System and Structural Barriers

Participants also described challenges in accessing healthcare services. Long distances to diagnostic facilities, transport costs, and inconsistent availability of services were frequently mentioned. A healthcare worker noted:

“Some miners travel long distances, and when they get here, sometimes we don’t have the machines working or enough staff.”

These barriers reinforce the delays identified in the quantitative findings, highlighting the role of structural constraints in limiting timely diagnosis and treatment.

## Integration of Findings

Across themes, the findings show that delayed care-seeking is not simply a matter of individual choice, but is shaped by the interaction of economic necessity, social stigma, and constrained health system access. In this context, miners do not ignore symptoms; rather, they negotiate risk within the limits of their environment.

## DISCUSSION

This study examined the lived experiences, health inequalities, and systemic barriers influencing tuberculosis (TB) care among artisanal and small-scale miners in Zimbabwe. The findings show that delayed care-seeking is widespread, with 61% of miners seeking care more than four weeks after symptom onset. This pattern reflects a combination of occupational risk, socioeconomic vulnerability, and structural health system constraints.

Delayed care-seeking was strongly associated with socioeconomic conditions. The higher proportion of delay among miners without alternative employment **Table 2** highlights the role of economic vulnerability in shaping care-seeking behavior. Miners seeking care means interrupting income-generating activities, which reinforces delayed action despite the presence of symptoms.

This is further supported by the regression results in **Table 5**, where lack of formal employment remained a significant predictor of delay (AOR = 2.1; 95% CI: 1.3–3.4). In practical terms, this reflects the economic reality of mining communities. Recent studies also show that delays in TB care are shaped by a combination of patient-related, social, economic, and health system factors, reinforcing the multi-level nature of barriers to timely diagnosis (Samal, 2026; Sathar et al., 2024).

Miners rely heavily on daily income, and seeking care often means losing wages. In this context, delays are not only behavioural but also economic. Many miners prioritise immediate survival over health, especially when symptoms are initially perceived as manageable or routine. These decisions are shaped by unstable livelihoods and the absence of social protection mechanisms. These challenges are compounded by structural barriers such as long distances to health facilities, transport costs, diagnostic delays, and weak referral systems, which continue to drive delayed TB care (Krishnamoorthy et al., 2025). Even when symptoms are recognised, access to timely diagnosis is not guaranteed. These factors create a cycle where risk is high, awareness is limited, and access remains constrained, ultimately prolonging delays in care-seeking.

Education and TB knowledge also played a critical role. **Table 3** shows clear differences in knowledge across education levels, with only 16.4% of miners with no formal education demonstrating correct knowledge of TB symptoms. In the regression analysis (**Table 5**), low TB knowledge was the strongest predictor of delay (AOR = 2.5; 95% CI: 1.5–4.2). This suggests that even where services are available, limited understanding of symptoms and disease progression delays action. This study reinforces existing evidence but further demonstrates that knowledge and economic vulnerability are more influential than occupational exposure in determining delays in care-seeking, (Nhlema Simwaka et al., 2018; Corbett et al., 2017). The findings reinforce the importance of targeted health education, particularly among high-risk groups.

Occupational exposure remains a central driver of vulnerability. As presented in Table 4, miners with daily dust exposure reported the highest levels of respiratory symptoms, including cough (80%), night sweats (60%), and weight loss (51%). The strong association between dust exposure and cough ( $\chi^2 = 73.99$ ,  $p < 0.001$ ) highlights the scale of occupational risk. However, these symptoms are often normalised within mining environments. This normalisation reduces perceived severity and contributes to delayed care-seeking, even when symptoms are persistent.

Qualitative findings provide important context to these patterns. Miners described how stigma, particularly the association between TB and HIV, discourages early disclosure of symptoms. This aligns with the quantitative findings on delayed care, suggesting that social factors reinforce behavioural delay. In addition, similar findings have been reported in recent studies, where TB-related stigma, particularly its association with HIV, continues to delay care-seeking and treatment uptake in African settings (Foster et al., 2024; Ashaba et al., 2021).

The interaction between these factors is important. Economic pressure may delay initial care-seeking, limited knowledge may delay recognition, stigma may delay disclosure, and health system barriers may delay diagnosis. These findings are consistent with broader evidence from sub-Saharan Africa, which shows that TB outcomes are shaped by overlapping social, occupational, and structural determinants. Unlike many studies that emphasize occupational exposure as the primary driver of TB risk, this study shows that delays in care-seeking are more strongly shaped by socioeconomic and informational barriers.

## CONCLUSION

Delayed TB care-seeking among artisanal miners in Zimbabwe is driven by overlapping socioeconomic, informational, and structural barriers rather than occupational exposure alone. More than half of miners delayed seeking care, reflecting the cumulative effect of these constraints. The findings highlight that improving TB outcomes in mining communities requires more than expanding diagnostic services. Interventions must address the broader conditions that shape care-seeking behaviour, including economic pressures, social stigma, and structural barriers to access.

Targeted, actionable strategies are needed. These include integrating TB screening into mining activities and licensing processes, expanding mobile diagnostic services to mining areas, strengthening community-based health education, and improving coordination between the Ministries of Health, Mines, and Labour. Addressing stigma through community-led interventions is also critical to improving early care-seeking and treatment uptake. Efforts to control TB in artisanal mining settings must move beyond facility-based approaches and adopt integrated, community-oriented strategies that reflect the lived realities of miners. Without addressing these interconnected factors, delays in care will persist and continue to drive transmission.

## Strength and Limitations

A key strength of this study is its mixed-methods design, which enabled triangulation of quantitative and qualitative findings and provided a more comprehensive understanding of TB care-seeking among artisanal miners. The inclusion of multiple high-burden mining districts strengthens the contextual relevance of the findings.

However, the cross-sectional design limits causal interpretation, as the results reflect associations rather than temporal relationships. The use of self-reported data introduces the possibility of recall bias, particularly in relation to symptom onset and care-seeking timelines. Responses on sensitive issues such as stigma may also have been influenced by social desirability.

The use of purposive sampling may limit generalizability beyond the selected districts, as mining conditions and access to services vary across regions. Despite this, the study offers important insight into how socioeconomic conditions, knowledge, and health system constraints shape delayed TB care-seeking

## Declarations

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## Ethical Approval

Ethical approval was obtained from the relevant ethics review authority in Zimbabwe. Written informed consent was obtained from all participants. Participation was voluntary and confidentiality was strictly maintained.

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