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Delays to TB care among Zambian mineworkers: Application of the Three-Delay Framework

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Degree to be awarded: MPH

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A thesis submitted to the Faculty of the
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Abstract

Delays to TB care among Zambian mineworkers: Application of the Three-Delay Framework

By

Elizabeth F. Long

Mineworkers in countries with high prevalences of tuberculosis (TB) and HIV are at an increased risk for TB disease. Previous studies have estimated TB prevalence among this key population, but there is little data available on mineworkers' perceptions and attitudes towards TB care and treatment. The objective of this analysis was to understand mineworkers' barriers to TB diagnosis, care, and treatment in the Copperbelt and North-Western provinces of Zambia. The Centers for Disease Control and Prevention in conjunction with the Tropical Disease Research Centre in Zambia conducted a qualitative cross-sectional study consisting of 30 focus group discussions with 271 mineworkers. The Three Delay Framework was utilized to identify themes corresponding to each delay in TB care and treatment. Three themes emerged within the first delay, seeking care: fear of job loss, distrust in mine clinics, and stigma due to an association of TB with HIV. In delay two, reaching care, a lack of transport and mine supervisors' refusal to let workers leave for medical care emerged as themes. In the third delay, obtaining adequate care, mineworkers discussed a perceived lack of skilled healthcare workers, the involvement of the mining company in healthcare decisions, and a lack of follow-up care at annual exams as barriers. As evidenced by the analysis, mineworkers experience unique barriers to TB care and treatment that the general population does not face. A repeal of the 1999 Workers' Compensation Act, which prohibits an individual with a past TB diagnosis to work in the mines, is necessary to ensure that stigma and fear is decreased among this key transmission population. To facilitate care, partnerships between key stakeholders including mining companies and the national TB program must be formed to ensure the success of targeted interventions.

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CONTENTS

EXTENDED INTRODUCTION

MINING IN ZAMBIA

Zambia is a lower-middle income country in Sub-Saharan Africa that is rich in natural resources, specifically copper, cobalt, and gold. Mining of these resources accounts for over 15% of Zambia's gross domestic product and in 2017, according to the Zambia Statistical Office, the industry produced over 797,000 metric tons of copper (1). Over 70% of the nation's exports are attributed to the mining industry; Switzerland, China, and Singapore account for the purchase of over 65% of these exports (2). Since Zambia's independence in 1964, the government has owned and operated mines throughout the country. Due to a prolonged drop in copper prices, among other factors, the Zambia Privatization Act passed in 1993 and both Zambia Industrial and Mining Corporation (ZIMCO) and Zambia Consolidated Copper Mines (ZCCM) liquidated their assets and sold individual mines to private companies (1). The privatization of the mining sector, while seen as a benefit to the Zambian economy, led to detrimental effects for mining communities in the Copperbelt province, where the majority of the mines are located. The Zambian economy grew an average of 7.7% during the period of 2004-2013 but the number of individuals below the poverty line increased to over 60% (3). Because foreign investors purchased most mines in Copperbelt, even when copper costs soared, the profits did not benefit local communities.

Privatization affected infrastructure throughout the region, leading to reductions in the number of health and education facilities in the region. ZIMCO and ZCCM contributed large amounts of money to developing infrastructure and ZCCM adopted a policy of providing education and healthcare for mineworkers and their families throughout their lifespan (4). Because of this, all mines had health clinics or hospitals attached to them. After privatization,

however, the number of healthcare facilities in mining communities dropped and cost of care increased substantially. Hospitals in mining towns dropped by 40% and clinics dropped by over 50% as facilities were either turned over to the government or closed by the new owners (4). If mining companies continued to provide health care to their employees, it was no longer regulated by the government.

Currently, mining operations are prominent in both Copperbelt and North-Western provinces. While a majority of mines in Copperbelt province were established prior to the privatization act of 1993, the North-Western province is home to many new mining ventures that have appeared in the past 15 years. The increased involvement of foreign actors, particularly China, coupled with decreased oversight by the Zambian government has led to many concerns surrounding the treatment and health of mineworkers (5, 6). A mining company can employ mineworkers through a staffing agency as short-term contractors or hire them directly. Often, the type of employment a mineworker has can significantly impact their ability to access healthcare services. Mine companies are responsible for providing occupational health services such as silicosis and tuberculosis (TB) screening for their direct hire employees. Furthermore, many offer health insurance and mine clinic access to direct hires; however, this same courtesy is not extended to contractors.

The Zambian government, through the Occupational Health and Safety Institute (OHSI), oversees environmental safety of mining operations, but day-to-day oversight of health, safety, and labor regulations appear to be lax, particularly in the North-Western province (7). Provision of healthcare is inconsistent between mines and regions. OHSI tracks the number of workers that are hired directly by mining operations, but they do not have data regarding the number of individuals working as contractors or the number of former mineworkers living in the region.

Health problems and occupational hazards experienced by this group are likely underreported due to weak oversight and monitoring of this population (8).

MINEWORKERS: A KEY POPULATION

Over the past two decades, TB incidence rates have almost doubled throughout sub-Saharan Africa. Mineworkers experience a higher incidence of TB disease than any other key population; it is reported to be up to 10 times higher than the communities of origin (9). They are more susceptible to developing TB disease for a number of reasons: time spent in crowded spaces with potential repeated exposure to infectious individuals, silica and dust exposure, and higher rates of HIV. Other factors such as socioeconomic status also play a role.

While the country has an estimated HIV prevalence of 12.4% among adults aged 15-49, Copperbelt province, home to the greatest number of mineworkers, has an HIV prevalence of over 18% (10). Roughly one-third of HIV negative mineworkers will experience seroconversion during their first 18 months of employment (11) and between 25-30% of mineworkers are HIV positive (12, 13). Individuals who are HIV positive are five times more likely to be diagnosed with TB disease than HIV-negative individuals. This risk is compounded by silicosis, an irreversible hardening of lung tissue caused by occupational exposure to silica dust, which can lead to weak lung function, lung cancer, and increased susceptibility to lung diseases (14). Mineworkers diagnosed with HIV and silicosis have a TB incidence rate that is 15 times higher than HIV negative mineworkers without silicosis (13).

Migration patterns of mineworkers play a large role in both HIV and TB transmission. Regional estimates suggest that up to 30% of tuberculosis (TB) in Southern Africa is a result of transmission between and from miners (15). Interrupted access to medical services due to migration can lead to poor treatment adherence for both TB and HIV. Poor adherence can lead to

high HIV viral loads, increasing the likelihood of HIV transmission. TB treatment interruptions can lead to an increased number of cases of antibiotic-resistant TB. Mineworkers who spend significant time away from their partners due to migration for work are more likely to engage in risky sexual behavior and contract sex workers (16) leading to higher incidence of HIV. The World Health Organization (WHO), World Bank, and the Centers for Disease Control and Prevention (CDC) have identified mineworkers as a key population and are currently in the planning stages of targeted interventions to interrupt transmission of HIV and TB.

ZAMBIA ASSESSMENT OF TB AND HIV IN THE MINES (ZATHIM)

In 2017, the Tropical Disease Research Centre (TDRC) of Zambia and the Zambia National TB program, with technical support from the CDC in Atlanta, Georgia, USA, conducted a study aimed at understanding mineworkers' perceptions and utilization of healthcare as well as their labor migration patterns. The primary objectives of the study were 1) to determine and document the current migration patterns of the mining population in Zambia, 2) to assess TB-specific knowledge and attitudes and describe health-seeking practices of mineworkers, and 3) to assess mineworkers' perceptions of a TB diagnosis, acceptability of TB treatment, and preferences for healthcare. The multi-armed study included focus group discussions (FGDs) and knowledge, attitude, and practice (KAP) surveys with current and former mineworkers, KAP surveys with healthcare workers, and observational assessments and interviews with key informants at both government and mining-operated health facilities. The data was gathered between October 2017 and January of 2018 in the Copperbelt and North-Western provinces.

The ZATHIM study protocol was reviewed and approved by the Tropical Diseases Research Centre Ethics Review Board, the Zambian National Health Research Authority, and the

Centers for Disease Control and Prevention (USA). All participants provided written, informed consent prior to participation.

JUSTIFICATION OF ANALYSIS

Despite the wealth of research that shows how mineworkers are a key population in the transmission of TB and HIV, most available research focuses on well-established mines in South Africa and the impact of migrant mineworkers from neighboring countries on prevalence. Very little published data about the prevalence of HIV and TB among Zambian mineworkers is available and no data regarding institutional and/or perceived barriers to care exists. Mineworkers, due to their high levels of movement throughout the country, require targeted interventions. The lack of data supports the idea that current interventions are not addressing this key population in a meaningful way. The ZATHIM study, using KAP surveys and FGDs, identified a fear of job loss due to TB diagnosis as a primary finding. This theme, while important, does not fully explain what leads mineworkers to delay seeking care for TB and HIV. A deeper dive into the focus group transcripts is necessary to understand barriers to care among mineworkers. The purpose of this analysis is to gain a more profound understanding of key barriers to seeking TB and HIV care among mineworkers and former mineworkers, in order to develop targeted health-related interventions to decrease transmission rates of HIV and TB among this key population.

OBJECTIVES OF THIS ANALYSIS

This analysis aims to:

1) Identify and characterize perceived barriers to seeking and obtaining TB and HIV care;
2) Explore variation by region or gender through a comparative analysis between Copperbelt vs. North-Western provinces and men vs. women; and

3) Inform intervention strategies in the areas of TB care and retention that would be most beneficial to current and former mineworkers.

DEFINITION OF TERMS

ART	Anti-Retroviral Treatment
CDC	Centers for Disease Control and Prevention, Principal investigators of ZATHIM
EBSCO	Elton B. Stephens Company
FGD	Focus Group Discussion
GDP	Gross Domestic Product
HCW	Health Care Worker
HIV	Human Immunodeficiency Virus
KAP	Knowledge, attitudes, and practices
OHSI	Occupational Health and Safety Institute, a division of the Zambian government
PEPFAR	President's Emergency Plan for AIDS Relief
TB	Tuberculosis bacilli
TDRC	Tropical Disease Research Centre, Implementing Partner in Zambia
WHO	World Health Organization
ZATHIM	Zambia Assessment of TB and HIV in the Mines
ZCCM	Zambia Consolidated Copper Mines
ZIMCO	Zambia Industrial and Mining Corporation

LITERATURE REVIEW

In order to gain a better understanding of existing research in the area of care-seeking behavior among mineworkers, the following topics were examined via comprehensive searches on PubMed and Elton B. Stephens Company (EBSCO). HIV & TB epidemiology in Zambia, mineworkers as a key population for TB/HIV transmission, and health-seeking behaviors of mineworkers. Additionally, an introduction on prior use of two theoretical frameworks employed in the analysis of the focus group transcripts, the Health Belief Model and the Three Delays Framework, has been included.

TUBERCULOSIS AND HIV BURDEN IN ZAMBIA

Transmission of tuberculosis bacilli occurs person to person through infectious air droplets. When an individual with active TB disease coughs, shouts, or sneezes, droplets release into the air and are able to infect another individual who inhales those air droplets (17). Many risk factors can increase the likelihood of developing TB disease including repeated exposure to an infectious individual or having a weak immune system. A WHO estimate from 2017 found the TB incidence rate of 361/100,000 though limitations exist with the reliability of surveillance data (18). Men experienced a risk two times that of women and the prevalence of TB was two to three times higher in urban versus rural areas. The authors believed that the current surveillance system is not capable of capturing and diagnosing many cases of TB (19) and emphasized the need for more intense and innovative approaches to TB control. One of these strategies must focus on mineworkers as a key population in the transmission of TB.

HIV is also a major public health problem in Zambia. The US President's Emergency Plan for AIDS Relief (PEPFAR) labels Zambia as a priority country and provided $385,000,000 in aid during fiscal year 2018 to address the HIV epidemic (20). The 2017 prevalence of HIV among 15-49 years old, according to UNAIDS, was estimated at 11.5% (21). The Demographic

Health Survey of 2014 found that Copperbelt province, home to the largest number of mining operations in the country, was estimated to have an HIV prevalence among adults aged 15-49 years of 18.2%, the highest in the country. In contrast, North-Western, which is considered an underdeveloped province, was found to have an estimated HIV prevalence of 7.2% (10). HIV diagnosis data for many key populations including sex workers, men who have sex with men, and drug users is collected but mineworkers, despite having a higher risk of contracting and transmitting HIV and TB, are not closely monitored.

MINEWORKERS AS A KEY POPULATION FOR TB & HIV CONTROL

Mineworkers are more susceptible to contracting TB for many reasons including crowded living quarters, silica and dust exposure, and working in enclosed spaces with recycled air. The incidence rate of TB among mineworkers is around 5 to 6 times higher than that of their home communities (22). Mineworkers and the presence of mining operations as a whole account for a portion of the population attributable risk of TB; as mining production in a country increases by 10%, the incidence rate of TB increases by 0.7% (22).

Mineworkers spend most of their time in crowded spaces, whether in the mine or in living quarters. Often, mines provide shared living quarters for their workers where individuals sleep in crowded locations with little access to fresh air (13). Existing in crowded locations creates more opportunities to interact with an individual with active TB disease. Coughing is a normal occurrence in a dusty environment like a mine, so the risk of inhaling infectious droplets is high. Air circulation and ventilation in mineshafts is poor also leading to greater susceptibility.

Silicosis, irreversible hardening of lung tissue caused by occupational exposure to silica dust which can lead to decreased lung function, lung cancer, and increased susceptibility to lung diseases (14), is a primary risk factor for TB, but is preventable through personal protective equipment. It often takes years to develop but can occur rapidly through intense, rapid exposure

and leads to lung impairment (23). Because silicosis damages the lungs, the risk of TB can increase by three times if a patient has silicosis (13). The Zambian government agency dealing with occupational health requires that mineworkers be screened annually for silicosis but importantly, this screen does not include miners hired through contracting agencies. A study found that countries that mined for gold (higher levels of silica exposure), controlling for HIV prevalence, were found to have TB incidence rates 48.5% higher than countries that didn't mine for gold (22). The risk of silicosis is also increased in copper mines. In 2016, researchers in Zambia performed chart reviews of mineworkers from three underground copper mining operations to determine TB status and compared those results to cumulative air samples taken every 90 days by OHSI (24). Their comparison revealed that high levels of exposure to silica dust led to an increased risk for pulmonary TB.

Regional estimates suggest that up to 30% of tuberculosis (TB) in Southern Africa is a result of transmission between and from miners (15). This high transmission risk among and from miners is often attributed to migration, decreased access to health services leading to late diagnosis and poor adherence, HIV status, and low socioeconomic status. If miners are unable to access health care, whether because of fear and stigma, lack of time or money, or the absence of services, they will not receive timely TB diagnosis and treatment. Delayed diagnosis prolongs the infectious period and provides additional opportunities to transmit the bacteria to others.

Migration also presents a unique challenge to stopping TB transmission. Living and working in two different places can create a disruption in access to health care services (25). For example, an individual diagnosed with TB and provided with treatment while home on leave are unable to access medication once they return to the mine because there is no referral system in Zambia. Frequent interruptions in treatment can lead to an increased risk of developing antibiotic

resistant TB and facilitating the spread of disease in the community. A majority of research on the effect of migration on TB incidence is from South Africa given that a majority of their workforce migrates from neighboring countries. ZATHIM data, though, revealed that a majority of mineworkers migrate between regions of Zambia for work, a factor that could have an effect on decreasing transmission rates. Moving between regions also involves spending significant periods on crowded public transportation, providing yet another opportunity to transmit TB to non-mineworkers.

Mineworkers also have a higher risk of contracting and transmitting HIV. One estimate from a study in South Africa estimates that approximately 25% of mineworkers are HIV positive (12). A different study showed that roughly one-third of HIV negative mineworkers will experience seroconversion during their first 18 months of employment (11). One reason for this higher risk of contraction and transmission is that many miners in-migrate to work from a different city or province with high HIV prevalence. Given that they often spend long periods away from home, they are more likely to participate in transactional sex, often without a condom (16, 26, 27) and relay sexually transmitted infections to their normal partners. One study at a copper mine in North-Western province, Zambia found that economic vulnerability leading to increased transactional sex, low levels of preventative interventions, high stigma, inequitable health care access, and low condom use were factors in a higher risk of HIV transmission in mining communities (28).

Another factor that causes mineworkers to be a key population in transmission is a lack of anti-retroviral treatment (ART) adherence. If a patient's HIV viral load is left uncontrolled because of poor ART adherence, they are more likely to transmit the virus to others and are more susceptible to developing TB disease. A 2011 study of 19 South African mineworkers found that

both social and psychological barriers such as the decision to disclose HIV status to partners or friends, stigmatization of treatment, social support, and attitudes towards ART contributed to poor medication adherence (26). Another study involving 26 male artisanal gold miners in Uganda found similar results regarding ART adherence (29). The researchers reported fear of exclusion in the workplace, an inability to provide financially if they were spending money and time to obtain medication, and a fear of appearing weak (29) as barriers to adherence. These factors will not only affect medication adherence but may prevent the mineworkers from seeking care in the first place.

HEALTH SEEKING BEHAVIOR & BARRIERS TO CARE FOR MINEWORKERS

Very little published research exists that focuses on mineworkers' care-seeking attitudes and practices. Even less research is available about mineworkers' perceived barriers to obtaining care. A 2016 study examined health-seeking behavior among individuals with presumptive TB in Zambia (30). The researchers conducted 6,708 structured interviews with individuals with presumptive TB regarding the relationship between symptom onset and care seeking (19). They found that only 35% of the presumptive TB cases sought care, primarily at public health facilities. Males, younger individuals, and urban dwellers were less likely to seek care for TB symptoms and of those who sought care, most waited three weeks (30). Their finding that younger males are less likely to seek care is significant for the mineworker population.

A recent study (2017) used in-depth interviews, FGDs, and participant observation to examine social and behavioral barriers to TB care delivery among South African mineworkers and their families (12). The researchers found that, overall, mineworkers lacked knowledge about TB symptomology, transmission, and treatment. Additionally, stigma and a general distrust of the health care system to properly diagnose and treat TB disease prevented individuals

from seeking care. To the best of our knowledge, this study is the only available published article using qualitative data collection to assess mineworkers' perceptions of barriers to care.

HEALTH BELIEF MODEL AND THE THREE DELAY FRAMEWORK

The Health Belief Model (HBM), a theoretical framework focused on understanding and explaining health behaviors, has been utilized in many published articles to explain barriers to TB treatment adherence (31). The model contains six domains: perceived susceptibility, perceived severity, perceived barriers, perceived benefit, cue to action, and perceived self-efficacy. The HBM suggests that the following conditions must be met to increase the likelihood of TB medication adherence: 1) patients have a baseline knowledge of TB disease and want to remain disease-free, 2) patients must believe that they are vulnerable to TB and that it is a serious health problem, 3) that treatment and adherence can cure TB, 4) a stimulus (either internal or external) triggers a patient to take TB medication, and 5) self-efficacy must lead a patient to follow TB treatment (31). The HBM was the theoretical framework that guided the ZATHIM study; specifically, the HBM was utilized to design the focus group discussion guide and employed in the design of the codebook used for qualitative analysis of the focus group transcripts.

A study of rural-to-urban migrant workers in China used components of the HBM to design in-depth interview guides to understand TB prevention and care seeking behavior (32). After analysis, they determined that TB knowledge and perceived susceptibility were the primary factors influencing participants' care-seeking behavior (32). A separate study in Ethiopia utilized the HBM to understand patterns of adherence to HIV and TB treatment. After analysis of in-depth interviews with TB/HIV co-infected patients and health care workers as well as two FGDs (33), the researchers found that adherence improved with positive beliefs about TB curability, the severity of a TB/HIV co-infection, and social support. Barriers to adherence included side

effects, stigma, lack of communication with health care workers, finances, and the number of pills (33). Both of these studies illustrate how valuable the application of the HBM can be when examining patients' perceived barriers to treatment adherence for HIV and TB.

The Three Delays Framework (TDF) was originally designed and utilized to examine maternal mortality and proposes that the majority of mortality is due to delays in 1) deciding to seek medical care, 2) reaching a healthcare facility, and 3) obtaining adequate care when at the facility (34). The researchers maintain that these three delays are not independent and that addressing these delays in program design will lead to interventions that are more appropriate. To our knowledge, TDF had not previously been utilized to understand barriers to seeking TB/HIV diagnosis or treatment, this framework has been applied to health problems outside of maternal mortality. One study used the framework to examine caregivers' perceptions on seeking care for pneumonia for children under five and recommended interventions based on specific delays to care (35). Another study applied the three delays model to examining barriers to civil registration in Indonesia (36). The success of these novel applications of the framework indicate that it is potentially useful for health and social problems.

SYNTHESIS

The results of this literature review highlight a gap in research surrounding care-seeking behavior and perception of care among mineworkers. Both TB and HIV present significant public health burdens to Zambia and although mineworkers are a key population because of their role in transmission of HIV and TB, no published data was available regarding targeted interventions in Zambia. Only one article examining care-seeking behaviors in South African mineworkers is available but due to the small number of current mineworkers in the study, the results are limited. No qualitative studies focused on the knowledge, beliefs, and perceptions of

TB and HIV care among Zambian mineworkers appeared in the literature review. The Health Belief Model and the Three Delays Framework are useful tools in qualitative data analysis for examining barriers to health care. This analysis of FGDs will apply both of these theoretical frameworks to better understand care-seeking behavior for TB and HIV among mineworkers and former mineworkers.

MANUSCRIPT

Delays to TB care among Zambian mineworkers: application of the Three-Delay Framework

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SUMMARY ABSTRACT

Setting: Mineworkers in countries with high prevalences of tuberculosis (TB) and HIV are at an increased risk for TB disease. Zambian mineworkers' perceptions and attitudes towards TB care and treatment are underexplored to date.

Objective: This qualitative study aimed to understand mineworkers' barriers to TB diagnosis, care, and treatment in the Copperbelt and North-Western provinces of Zambia.

Design: This was a qualitative cross-sectional study consisting of 30 focus group discussions with 271 mineworkers. The Three Delay Framework was utilized to identify themes corresponding to each delay in TB care and treatment.

Results: Fear of job loss, distrust in mine clinics, and HIV stigma contributed to delays in mineworkers' decisions to seek care. A lack of transport and the mine supervisors' refusal to let workers leave for medical care emerged as barriers to actually reaching healthcare facilities. Finally, mineworkers discussed a perceived lack of skilled healthcare workers, the involvement of the mining company in healthcare decisions, and a lack of follow-up care at annual exams as barriers to obtaining adequate care.

Conclusion: Mineworkers experience unique barriers to TB care and treatment. To facilitate care, partnerships between key stakeholders including mining companies and the national TB program must be formed to ensure the success of targeted interventions.

INTRODUCTION

Zambia is a lower middle-income country in Southern Africa that is rich in natural resources such as copper, cobalt, and gold. Mining of these resources accounts for over 15% of Zambia's gross domestic product (1) and over 70% of the nation's exports (2). The majority of mining operations in Zambia are located in Copperbelt and North-Western provinces. Although most mines in Copperbelt province were established many years ago, the North-Western province is home to new mining ventures that have been built by private corporations during the past 15 years.

Tuberculosis (TB), a mycobacterial disease that transmits from person to person via infectious air droplets, presents a serious public health burden to Zambia. The World Health Organization (WHO) estimated TB incidence in Zambia in 2017 of 361/100,000 persons (18). Mineworkers experience a high incidence of TB disease, reported to be up to 10 times higher than the general population (9). Mineworkers are more susceptible to contracting TB due to an increased chance of repeat exposure to an infected individual in crowded living quarters and enclosed workspaces with recycled air. Silica and dust exposure also aggravate mineworkers' airways and compound the already elevated risk for TB. Regional estimates suggest that up to 30% of tuberculosis (TB) in Southern Africa occurs as a result of transmission between and from miners (15).

Mineworkers are also at higher risk for TB due to high HIV rates in the population. The Demographic Health Survey of 2014 estimated that Copperbelt province, home to the largest number of mining operations in the country, had an HIV prevalence of 18.2% among adults aged 15-49, the highest prevalence of any region (10). In Southern Africa more broadly, roughly one-

third of HIV-negative mineworkers experience seroconversion during their first 18 months of employment (11) and an estimated 25-30% of mineworkers are HIV-positive (12, 13).

Despite the wealth of research demonstrating TB and HIV risk for Zambian mineworkers, little is known about their healthcare experiences. Most available research has focused on well-established mines in South Africa. Zambian mineworkers, due to their high levels of movement throughout the country, require targeted interventions to engage and retain them in TB and HIV care. Given the paucity of contextual data describing Zambian mineworkers, we sought to identify and understand mineworkers' perceived barriers to seeking TB and HIV care.

STUDY POPULATION AND METHODS

Focus group discussions (FGDs) used in this analysis were drawn from the Zambia Assessment of TB and HIV in the Mines (ZATHIM) study, a joint venture between the Zambian TB Control Program, the Tropical Disease Research Centre (TDRC), and the U.S. Centers for Disease Control and Prevention (CDC) (37). ZATHIM was conducted between October 2017-January 2018 in the Copperbelt and North-Western provinces of Zambia. The study aimed to understand knowledge, attitudes, and practices surrounding TB diagnosis and treatment among mineworkers, and to assess the TB cascade of care in health clinics. The TB cascade of care refers to each step a patient undergoes in relation to TB: screening, sputum collection, diagnosis, treatment, and cure. The ZATHIM study included individual qualitative semi-structured interviews, focus group discussions (FGDs), and structured observations. Respondents included current and former mineworkers, as well as health care workers (HCWs). Full details of the ZATHIM protocol are described elsewhere (37).

We utilized two theoretical frameworks to analyze this data: the Health Belief Model (HBM) and the Three Delay Framework (TDF). The HBM, a framework focused on understanding and explaining health behaviors, has been applied to explain barriers to TB treatment adherence (31-33). The model contains six domains: perceived susceptibility, perceived severity, perceived barriers, perceived benefit, cues to action, and perceived self-efficacy. The research team used these domains to design the FGD guide and the codebook for primary analysis. The TDF, originally applied to maternal mortality, proposes that the majority of mortality is due to delays in 1) deciding to seek medical care, 2) reaching a healthcare facility, and 3) obtaining adequate care when at the facility (34). To the best of our knowledge, this analysis is the first application of the TDF to TB care-seeking behavior.

ZATHIM was approved by the Tropical Disease Research Centre (TDRC) Institutional Review Board (IRB), the Zambia National Health Research Authority (NHRA), and the U.S. Centers for Disease Control and Prevention (CDC). Additionally, the Emory University IRB approved this secondary analysis.

PARTICIPANTS

ZATHIM aimed to complete 33 FGDs (three per region: one with current mineworkers, one with former mineworkers, and one with either women or young men working in the mines). Women and young men (18-30 years) represent a small proportion of total mineworkers, so these groups were purposively targeted to ensure the inclusion of varying perspectives. Participants were recruited through outreach to mining communities, advertisement at mining companies and healthcare facilities, and referrals from community leaders and HCWs. A snowball sampling technique was utilized to recruit additional participants after the initial referrals. Participants were eligible to participate if they were currently working or had previously worked for a

minimum of one year in a mine. All participants provided written informed consent prior to the start of the FGDs.

Sociodemographic data including age, gender, educational level, marital status, work status (current or former employee), type of employment (direct hire with mine company or contract), and duration working in the mine was collected from each FGD participant. FGDs were conducted in Bemba, the local dialect. FGDs were transcribed and translated from Bemba to English by study staff in Zambia and verified by study supervisors.

Data Analysis

Descriptive statistics were used to summarize sociodemographic data of the FGD participants. Frequencies were calculated with SAS 9.4 (Cary, North Carolina). A team of five researchers (4 US-based, 1 Zambia-based) initially reviewed four transcripts and identified recurring elements of participants' perceptions about TB and accessing TB services. The coding approach included creation and application of descriptive codes (e.g., *healthcare setting, time period in relation to mine work*), deductive codes derived from the HBM (e.g., *perceived severity, self-efficacy*), and inductive codes that emerged from the data (e.g., *care seeking)*. Research team members independently coded transcripts and met weekly to assess inter-coder agreement, discuss emerging themes, and modify the codebook. The team coded a minimum of one transcript from each data collection site using the team-based approach until researchers felt that they had reached data saturation. In total, researchers coded 22 transcripts and reviewed the remainder of the transcripts to ensure that no novel theme was missed.

For this secondary analysis, any instance of the code "*care-seeking"* was highlighted for additional review. The lead analyst examined emerging sub-themes within the care-seeking code using the Three Delay Framework (TDF). Where a delay in care-seeking behavior was noted, the

passage was then categorized into one of the three delays: 1) delay in seeking care, 2) delay in reaching care, or 3) delay in obtaining adequate care. Transcripts were re-coded at a separate sitting two weeks after the initial coding to ensure replicability. All analyses were performed with Nvivo 11.0 (QSR International Pty Ltd., 2015), a qualitative data analysis package.

RESULTS

Thirty FGDs with 271 total participants were conducted, of which 22 (73%) were in Copperbelt province (n=206 participants; 76% total participants) and eight (27%) were conducted in North-Western province (n=65 participants; 24% total participants) (Table 1). Of the 30 FGDs, 18 (84%) were with current mineworkers, eight (27%) were with former mineworkers, and four (13%) were with a combination of current and former mineworkers. Four FGDs were comprised of female mineworkers. The median age was 37 (interquartile range [IQR] 29, 45) and over 90% of participants were male. Over 70% (n=198) of FGD participants had at least 9 years of education and almost a quarter (24%) attended some college, or received a technical or college degree. Most (66%) participants were current mineworkers and the median number of years worked in mines was nine (IQR 5, 15).

There was a clear division in mineworkers' care-seeking behaviors for injuries or common illnesses versus for TB/HIV testing and treatment. Mineworkers reported few delays to seeking care for work-related injuries or common illnesses, and most reported preferring mine-operated facilities for those services. In contrast, most participants preferred to seek TB care at government or private health facilities. In describing TB care-seeking patterns, participants explained factors contributing to each type of delay in the TDF.

DELAY 1: DELAY IN SEEKING CARE FOR TB

Three primary themes emerged when examining what led mineworkers to delay seeking care for TB: fear of job loss, distrust in the mine-operated health system, and the stigma of a TB diagnosis due to its association with HIV (Table 2). Other themes, such as a preference for seeking non-hospital based care first, a lack of TB knowledge, and a fear of the TB diagnosis itself were less prominent (Table 3).

Fear of Job Loss

A delay in seeking care due to a fear of job loss, described as a certain consequence of a known TB diagnosis in the mines, was discussed in every FGD. A current mineworker stated:

> *"Most of the mineworkers believe that when you are diagnosed with TB then…that's the end, I have AIDS…they will fire me from my job, but if…[management] remove that fear of losing their jobs, you will find that a lot of miners will be going for testing and will be eager to know their statuses."*
>
> –Male, 29, Copperbelt

Mineworkers often related the discussion surrounding job loss to a lack of understanding about the mine company's policy regarding sick days and the worry that if they take too many days off, they will lose their contract. This fear was closely tied to mineworkers' stated preference for seeking TB and HIV care at either government or private health facilities, instead of mine-operated facilities. One participant stated:

> *"When [the mine facilities] diagnose you with TB, then immediately you will be dismissed. So if you go to another hospital on your own to get treated and they find that you have got TB, it's better you are getting treatment privately unlike if [the mine hospital] test you and the mines know that you have TB, then you will be dismissed."*
>
> - Male, 34, North-Western

Distrust in mine-operated health facilities

The second theme, distrust in the mine-operated health facilities, is also associated with a fear of job loss. This distrust was described as not only a lack of confidentiality but also a

perception that mine-contracted HCWs would not believe that the mineworkers were sick. A current mineworker stated:

> *"…we fail to go to the hospital because they have no confidentiality, so that hinders us to access the health services from there. So unless you just become severely sick and that's when you go to get tested for HIV or TB, but you can't go there just like this because they have no confidentiality…"*
>
> -Male, 28 years, current, North-Western

This lack of patient-provider confidentiality in mine-operated clinics is also discussed with respect to the third delay (delay in obtaining adequate care). Specifically addressing the perceived distrust between mineworkers and HCWs, a current mineworker in the Copperbelt stated:

> *"…you will be shocked that when you get to the [mine] clinic, the person you will find will say 'this department a lot of you are coming here'…insinuating that you are running away from work…they are not focusing on your sickness or the complaint you went with."*
>
> -Male, 40, current, Copperbelt

Stigma

The final theme leading to delays in seeking care was the stigma of a TB diagnosis due to its association with HIV. In many of the discussions, there was little differentiation between TB and HIV diagnoses. For many, the two diseases always appear together and lead to additional stigma. A current mineworker described this commonly held belief, "…a lot of people think that when somebody has TB then definitely they also have HIV/AIDS, so by the time you go and tell your wife…this news will get to work, and I will eventually lose my job" (Male, 32, North-Western). Mineworkers in most of the FGDs mentioned that a policy of mandatory HIV testing at health centers has deterred mineworkers from seeking care for TB. A mineworker in the Copperbelt stated, "…this same thing is what causes a lot of miners to avoid coming to the

hospital, this same system of checking your status before they do anything with you, this has also contributed to people dying in their homes" (Male, 27).

DELAY 2: DELAY IN REACHING CARE

Two primary themes emerged from the FGDs as causes of a delay in reaching care: a lack of transport and the mine shift supervisor's refusal to allow workers to leave the job site to seek medical care (Table 2). An additional theme, the time or cost associated with reaching the mineworker's preferred healthcare facility, is important for understanding what leads to delays in reaching care but appeared in fewer passages (Table 3).

Lack of Transport

In discussing problems with transportation, participants described the location of the mines in relation to health facilities. One mineworker stated: "…from where you are up to the point of where you are working, to the health facility, or to the clinic, maybe it might take maybe two hours, you see… so the challenge is transportation… the urgency plus transportation" (Male, 37, North-Western). Many participants mentioned that mines provided transportation services to health clinics were primarily for medical emergencies, and that mineworkers were generally left to fend for themselves for transport to the clinic for non-emergent medical cases. Former mineworkers described that when the mines were Zambian-owned, the provision of transport to clinics by the company was much more common. One participant stated:

> *"We used to see how our parents used to work in the mines [a] long time ago, we used to see an ambulance coming for them at home. For us, it's not there, you have to fend for yourself. So if you have no money, you will be forced to walk, meanwhile you are sick but you walk on foot."*
>
> -Male, 35, North-Western

Supervisors as a barrier

Mineworkers discussed relationships with their supervisors and the process by which they had to request sick leave while at work. While some mineworkers stated they did not have issues dealing with their supervisors when ill, others detailed extreme difficulties in leaving the mine to obtain care. A former mineworker stated:

> *"Yes, sometime back there used to be no problem but this time it has become difficult. This time for someone to just get permission, you really need to put up a fight. There are times when you do not get along well with the supervisor, he will just be refusing, and you cannot bypass him and go to a senior supervisor who is above him. You will just end up failing."*
>
> -Male, 35, North-Western

An additional perception that mineworkers discussed was that their supervisors refused because allowing individuals to leave would lead to a diminished workforce. In turn, this would affect the daily production of the mine and leave supervisors vulnerable. One individual stated, "Even if you are sick, they will not give you a referral to go back to the hospital. [Mine supervisors] would make sure that you complete the working hours which they have counted" (Male, 36, Copperbelt).

DELAY 3: DELAY IN OBTAINING ADEQUATE CARE

Three themes arose when examining what caused a delay for mineworkers to receive adequate care: a lack of skilled HCWs that adhere to standards of confidentiality, the perceived involvement of the mine company in treatment decisions, and a lack of follow-up care at annual silicosis testing (Table 2). A final theme, the lack of medications and diagnostic capacity at health centers, features less prominently in the FGDs but still presents an important challenge to obtaining adequate TB care (Table 3).

Lack of skilled HCWs at mine-operated health facilities

The lack of skilled HCWs at mine-operated facilities acted as a barrier to receiving adequate care in multiple ways. Participants believed that HCWs were unwilling to help mineworkers, that mine-contracted HCWs were less qualified, and that there was a lack of provider-patient confidentiality. Many mineworkers mentioned that the doctors at the mine clinics are young and believe them to be unqualified to provide appropriate care for their patients. Other mineworkers mentioned that many of the clinical officers had retired from government positions and in order to maintain a paycheck, were more focused on pleasing the mine company rather than caring for the mineworkers. Several mineworkers in the North-Western province mentioned that the doctors at their mine clinic are not Zambian and that they often run in to language and cultural barriers when obtaining care. One participant stated:

> *"The challenge sometimes is, we do not know whether those people we are going to find there are genuine, if they are qualified doctors. Because since it's a company that has brought its own people…their diagnostic procedure will differ from what the government facility will tell you, so there it brings a question mark whether the people that saw you screened you properly or the equipment they were using wasn't functioning well."*
>
> - Male, 37, North-Western

Obtaining inadequate care due to a lack of confidentiality was seen more often in the North-Western transcripts, especially in reference to one clinic. A female participant detailed how this lack of confidentiality could lead to a delay in obtaining medications due to travel:

> *"There is no privacy at our clinic at [Mine Clinic X] because this clinic belongs to the same company which has employed us…whatever sickness you have there, the HR have to know about. So, I would prefer, if I am sick and on ARVs to go and get them from the Copperbelt where I stay."*
>
> -Female, 32, North-Western

Distrust of mine-operated health facilities

Distrust in the mine-operated health system both leads individuals to delay seeking care and results in a delay in obtaining adequate care. In both provinces, mineworkers discussed their belief that the mining company directly affected the HCWs' decisions to provide sick leave.

They also discussed the idea that the mining company is likely to hide or delay providing results of TB tests in order to maintain their work force until the next contract season. One mineworker stated:

> *"[The employer's] practice is that immediately [when] you are diagnosed that you have TB, the hospital will not disclose to you that we have found you with TB, they will first inform the company, that's when the company will hide it from you. By the time you find out, they would have already known a long time ago."*
>
> -Male, 64, Copperbelt

Most mineworkers who expressed a distrust in the mine-operated facilities stated a preference for seeking care at a government or private facility or a desire to have government-contracted doctors staff mine facilities. A mineworker in Copperbelt province stated:

> "*After they do the X-ray tests and discover you have TB, they will not tell you, they will first inform your bosses like Human Resources. They will inform [HR] that R1 has got TB, and yet they will not inform you to say, 'we have found you with TB'. They won't tell you, they will just encourage you to say 'it will stop, it will stop, the way your chest is paining please use these drugs.' But if you go to a government hospital and go and complain to say, 'my chest, my chest', they will take you for X-ray and if they find you with TB, they will inform you instantly."*
>
> -Male, 27, Copperbelt

Lack of follow-up

According to occupation health and safety laws, mineworkers are required to get an annual silicosis screening (24). Throughout FGDs in both provinces, mineworkers were not sure if they also had a TB screening at these annual exams. Of those that believed they were screened for TB, they relayed that they do not learn the results of their annual exams in order to take action and start treatment for TB. One individual stated:

> *"…every year the company [does] take us for medical checkups [for] silicosis where they go and examine the chest…Mainly it's TB is the reason why we go for checkups every year. So the information, whether you are very sick or you have a problem, you have shown signs that you have TB, we do not get it early as miners. Because when we are examined there, we do not get results individually, it's the company, which keeps them. So unless you have time to go and do it on your own, that's when you will know the results for that…mainly a lot of people, it's not like they are reluctant. [By] the time they come to discover that they have TB, you could be in our last stage."*

–Male, 31, Copperbelt

Many mineworkers felt that the annual silicosis examination was not sufficient to protect them from TB. In addition to not learning TB results, a majority of the participants reported that they never learn the results of their silicosis screening. A current mineworker stated, "Every year you go and get tested [for silicosis], then they do not even tell us the results of those tests to inform us that you are affected by TB since you came here. No, they will just say, 'you are fit, you are fit'" (Male, 42, Copperbelt).

DISCUSSION

The most pervasive concern that led mineworkers to delay TB care was a fear of job loss. For many participants, this fear led to delays in seeking TB diagnosis. Additionally, mineworkers would seek out traditional cures for TB or travel long distances to see healthcare providers outside of the mining community, to prevent the mine from learning about their diagnosis. Similar results have been reported in South Africa, where mineworkers reported a fear of being asked to leave their job if diagnosed with TB, although most reported no actual job loss due to TB (12). For mineworkers in Zambia, many participants reported that the fear of job loss due to a current or past TB diagnosis was tied to The Workers' Compensation Act of 1999, which prohibits individuals with a past TB diagnosis from working in the mines (38).

The role of the mining company in building trust among its employees and within mine-operated health facilities is paramount to mineworkers' willingness to seek care for TB and their belief that they were obtaining adequate care. This study highlighted a lack of confidence in mine-operated clinics' healthcare workers due to a perceived lack of confidentiality, knowledge, and willingness to treat the patient's specific issues instead of following mine company guidelines. A lack of trust in health workers' ability to diagnose and treat TB was found in the

study of South African mineworkers (12). The findings of our study add to that work but also provide context for specific points in the care pathway where distrust impedes TB care.

Mineworkers in this study reported little stigma with TB alone but repeatedly discussed the stigma of TB due to its association with HIV as a barrier to seeking care. Participants in other qualitative studies highlighted the involvement of HIV in TB stigma and often blamed the patients for their diagnosis and reported that a TB diagnosis should bring them shame (39, 40). Since stigma can lead to self-isolation, non-adherence to medication, and poor treatment outcomes for both TB and HIV patients (39-42) it must be addressed within the mining community.

This research helps to fill a major research gap in understanding perceived barriers to care for TB among mineworkers. Although it is the second qualitative study that examines barriers to care among mineworkers, a key population for TB transmission, it is the first of its kind in Zambia. The Worker's Compensation Act provides a context unlike the study of South African mineworkers (12). Barriers such as the refusal of supervisors to allow mineworkers to seek care, or the lack of follow-up regarding silicosis and/or TB results from annual exams present unique challenges to care delivery within this population.

We considered the results of the analyses across groups to identify key, actionable recommendations within each delay of the framework. Within the first delay, seeking care for TB, several interventions are necessary to improve TB care-seeking behavior. The first is a repeal of the law prohibiting individuals with past TB diagnoses from working in the mines to decrease the stigma and fear of job loss. Additionally, education campaigns to teach mineworkers about the symptoms and treatment for TB, the difference between TB and HIV diagnoses, and where they can seek care for TB are necessary to improve care-seeking behavior.

To effectively address the second delay (reaching care), an intervention at the level of mining companies should focus on improving transparency of sick policies and promoting wellness and healthcare for its workers. Research shows that developing a healthy workforce will lead to decreased staff turnover, increased productivity, and reduced risk of fines, among other factors (43). Providing companies with evidence that a healthy workforce improves long-term productivity may help decrease the barrier that mineworkers encounter with supervisors refusing to allow the workers to seek care.

Within the third delay of obtaining adequate care, many mineworkers discussed a strong desire for government-employed medical staff to be placed at mine-operated health facilities. Their distrust in the mine-system to provide accurate and timely results of both silicosis and TB screening tests as well as their belief that mine-contracted HCWs do not follow government guidelines for TB and HIV testing led many to obtain second opinions at outside facilities. A majority of mineworkers appealed for the government to take a larger role in managing the health of mineworkers, extending silicosis screening to include TB and chronic illnesses such as diabetes and hypertension. Furthermore, mining companies should work to increase the provision of results from annual health exams and add TB screening to the essential pre-employment and annual exams provided to mineworkers if it not currently included.

LIMITATIONS

There are several limitations worth noting in the current analysis. Participants were recruited at mining facilities and health centers through key personnel and snowball sampling was used to identify the majority of participants. This sampling strategy may have led to a more homogenous sample of mineworkers. In order to address this homogeneity, women and young men were specifically targeted for inclusion. In addition, information on previous or current TB

diagnosis was not obtained from participants due to the potential sensitivity and stigma associated with TB disease. Had mineworkers disclosed a prior TB diagnosis, it may have been easier to identify where within the Three-Delay Framework mineworkers experience delays.

Finally, the parent study's FGD guide was based on the HBM and was not directly intended to elicit TB care information under the TDF. Had the use of the TDF been pre-determined, more detailed information related to the delays in care may have emerged. This framework, however, is a useful structure that can help policymakers and public health professionals develop targeted interventions based on when the delay in TB diagnosis is occurring.

CONCLUSION

This analysis highlights the unique barriers Zambian mineworkers face when seeking TB diagnosis, treatment, and care. A fear of job loss, distrust in mine-operated health facilities, and the perceived involvement of the mining company in medical decisions all point to the need for targeted interventions that involve partnerships between key stakeholders including the Zambian National TB Program, the mining industry, the Ministry of Health, and the Occupation, Health, and Safety Institute. A repeal of the Workers' Compensation Act to decrease fear of job loss, education campaigns focused on TB in mineworkers, and standardized health policies at mining companies should be considered.

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TABLE 1. DEMOGRAPHIC DATA FROM FGD PARTICIPANTS

Characteristic	**Overall (n=271)****	**Copperbelt (n=206)****	**North-Western (n=65)**
Age, n (%)			
20-25	26 (9.6)	23 (11.2)	3 (4.6)
26-35	104 (38.4)	65 (31.6)	39 (60)
36-45	76 (28)	58 (28.2)	18 (27.7)
46-55	45 (16.6)	40 (19.4)	5 (7.7)
56-65	19 (7)	19 (9.2)	-
66+	1 (0.4)	1 (0.5)	-
Gender, n (%)			
Male	248 (91.5)	199 (96.6)	49 (75.4)
Female	23 (8.5)	7 (3.4)	16 (24.6)
Years of education, n (%)			
Primary school degree (7)	8 (3)	7 (3.4)	1 (1.5)
Some high school or HS degree (9-12)	198 (73)	158 (76.7)	40 (61.5)
Some college/technical degree (13-15)	62 (22.9)	38 (18.5)	24 (37)
College degree or higher (16 and up)	3 (1.1)	3 (1.5)	-
Marital Status, n (%)			
Married	206 (76)	158 (76.7)	48 (23.3)
Divorced	1 (0.4)	1 (100)	-
Single	64 (23.6)	47 (73.4)	17 (26.6)
Mining Status, n (%)			
Current Mineworker	179 (66)	135 (75.4)	44 (24.6)
Former Mineworker	92 (34)	71 (77.2)	21 (22.8)
Type of Contract, n (%)			
Direct Hire by Mine	185(68.3)	139(75)	46(25)
Contracted	86 (31.7)	67(77.9)	19(22.1)
Years worked in mines, n (%)**			
1 year	17 (6.3)	12 (5.9)	5 (7.7)
2-5 years	64 (23.8)	46 (22.6)	18 (27.7)
6-10 years	76 (28.3)	49 (24)	27 (41.5)
11-15 years	47(17.5)	34 (16.7)	13 (20)
16-20 years	24 (8.9)	23 (11.3)	1 (1.5)
21-30 years	29 (10.8)	28 (13.7)	1 (1.5)
31+ years	12 (4.5)	12 (5.9)	-

**Two observations for the *Years worked in mines* variable were missing for Copperbelt Province, n=269 total, n=204, Copperbelt

TABLE 2. PRIMARY THEMES

Delay in Care	**Primary Themes**
Delay in Seeking Care	1. Fear of Job Loss 2. Distrust in mine-operated health systems 3. Stigma of TB diagnosis due to association with HIV
Delay in Reaching Care	1. Lack of Transport 2. Refusal of supervisor
Delay in Obtaining Adequate Care	1. Lack of skilled health care workers 2. Perceived involvement of mine company in treatment 3. Lack of follow-up care at annual exams

TABLE 3. SECONDARY THEMES

Delay in Care	Additional Themes	Examples of Quotes to Support Themes
Delay in Seeking Care	4. Fear of TB diagnosis	1. *"…[the mineworker] could know that he is suffering from TB…but he is feeling shy to go and get drugs from the hospital, if I go to the hospital to get drugs, people will start laughing at me."* –Male, 26, North-Western *"we all know that TB is curable, but most of us take the illness as if it is a disease…that just kills…all they will be thinking is that 'if I go to the clinic and they go and tell me that you have TB…it's better I don't go there so that I continue getting my salary'"* – Male, 39, Copperbelt
	5. Preference for seeking non-hospital based care first	2. *"…some go to traditional healers, even if they are suffering from TB, they feel they have been bewitched, so it is only a witchdoctor who can treat me, we still have fear to visit the hospital, and prefer traditional healers."* –Male, 36, Copperbelt *"…he will do what is commonly known as self-prescription-you buy some drugs from the community…takes those drugs whilst they wait to see thinking, 'maybe if I take these drugs, if I get better then I will continue going for work'"* –Male, 40, Copperbelt
	6. Lack of TB Knowledge	3. *"Mostly, what causes [a delay] is lack of knowledge, for instance you have TB but you do not know that it is TB you are suffering from. You can be coughing but you do not know…"* –Male, 36, Copperbelt *"don't even know the treatment for this same TB you are talking about…all they know is when you fall sick, you will die, you see…even a sickness which is curable, but because of working in the mine, you will not be up to date…"* –Male, 28, Copperbelt
Delay in Reaching Care	Time or cost associated with reaching the preferred healthcare facility	*"…[miners] are scared [HCW] will start telling others…so as a result, they want to travel maybe from here to Livingstone, just to go and get that service there…"* –Male, 37, North-Western *"…it's better a person with TB is getting treatment from a government health facility because he will be getting it…free of charge, but if he was getting it from a private facility and then the contract is terminated, he will not be able to access treatment and that person might end up dying."* –Male, 34, North-Western *"We are earning little money here…he might not even have transport money to go back and collect [TB] medication. At the end of the day, you will find that people are getting sick and dying each and every day because of 'I will go, I will go'…meanwhile, he/she is not on medication."* –Female, 33, North-Western
Delay in Obtaining Adequate Care	Lack of medications and diagnostic capacity at health centers	*"When you join the mines, among the conditions of service, they provide health services. We're even given designated hospital to go to. It's just that nowadays, they may provide, but medication is not there. You can go to the hospital and then you find that the medication that was prescribed for you is not available."* –Male, 39, current, Copperbelt *"…if it's TB…when you produce saliva, [mine health workers] bring to the general hospital. At the general hospital, they will say no, you wait. Time is wasted. Instead of them having their own equipment at the mines which they can be using, so it's at the general hospital."* – Male, 45, North-Western

PUBLIC HEALTH IMPLICATIONS & RECOMMENDATIONS

Findings from the current study address a critical knowledge gap and provide concrete and actionable guidance to inform interventions specific to mitigating the burden of TB and HIV among mineworkers. As evidenced by the literature review, there is no existing information regarding access to TB and HIV care among Zambian mineworkers. Only one article using qualitative methods to understand barriers to care could be located but focused on mineworkers in South Africa (12). While some of the themes were present in both studies, others, such as the lack of medications at healthcare facilities, the refusal of the supervisor to allow sick time, the involvement of the mining company in healthcare decisions, and a lack of follow-up care from annual exams are novel and unique to this study.

As part of the FGDs, mineworkers made recommendations on how to improve access to TB and HIV diagnosis and treatment. We considered those recommendations along with the results of the analyses across groups to identify key, actionable recommendations within each delay of the framework. Within the first delay, seeking care for TB, several interventions are necessary to improve TB care-seeking behavior. The first is a repeal of the law prohibiting individuals with past TB diagnoses from working in the mines to decrease the stigma and fear of job loss. Additionally, education campaigns to teach mineworkers about the symptoms and treatment for TB, the difference between TB and HIV diagnoses, and where they can seek care for TB are necessary to improve care-seeking behavior.

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Portions of the results from the initial analysis of the FGDs were utilized to make recommendations at a meeting of key stakeholders including TDRC, CDC, Occupational Health, mining company representatives, and government officials. One of these recommendations was to repeal the section of the Workers' Compensation Act of 1999 that prohibits an individual with a past TB diagnosis from working in the mines. The results of the study were also discussed at a meeting with Zambian parliamentarians in February 2019. It is the hope of the study team that the Zambian parliament strongly consider overturning this section of the law to decrease stigma associated with a TB diagnosis and improve active case finding among mineworkers and their families.

The CDC in conjunction with the Zambian TB Control program and TDRC is developing an intervention protocol based on the results of the ZATHIM study. The pilot study will focus on improving case finding and tracking mineworkers in two of the cities targeted by this study. In addition, The World Bank, a key actor in this field, is developing a deeper understanding of the role of mineworkers in TB transmission and supporting interventions focused on health systems strengthening in Zambia, Lesotho, Malawi, and Mozambique (44). These interventions will focus on the provision of care to mineworkers and improving existing health systems' ability to track this key population.

The qualitative portion of this study was comprehensive. Because the results of this study cannot be generalized to mineworker populations outside of the mining communities in Copperbelt and North-Western provinces where this study was completed, additional research on mineworkers in other regions or countries may be necessary. Additionally, although women make up a small portion of the total number of mineworkers in Zambia, our sample size was likely insufficient to detect true differences in barriers to TB care between genders. Furthermore, although contract vs. direct hire occupational status was noted during secondary data analysis, a further examination of these two populations may reveal differences in care-seeking behavior. Given the discussion on differences in application of mine company policies, one recommendation is to research currently implemented health policies at contracting agencies to see if disparities in care exist.

The results of the ZATHIM analysis brought attention to a highly vulnerable population in Zambia and provided a glimpse into what causes this population to hide TB diagnoses and delay care and treatment. Efforts must be made to educate mineworkers around TB and HIV,

create referral systems within Zambia so that mineworkers can seek care where they feel most comfortable, and standardize health-related policies at mining operations.

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