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## Tuberculosis in the mines of Zambia: A case for intervention

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## ABSTRACT

Zambia is among the sub-Saharan countries highly burdened with tuberculosis (TB) and has an estimated prevalence rate of 638 per 100 000 population in those aged 15 years and above. The mining industry is the main contributor to the country's gross national product, although it is associated with public health challenges, with TB in the mines being among the occupational health diseases having a negative economic impact and threatening to delay the control of TB in the country. We reviewed available evidence on the extent of the burden of TB in the mines so as to inform the development of targeted interventions for the post-2015 End TB Strategy. This was a review of published data from Medline/Pubmed, Cochrane Library and Embase, including unpublished "grey" literature on the burden of TB and the risk factors of TB in the mines of Zambia. There is limited research in Zambia to fully understand the burden of TB and risk factors associated with TB in the mines. However, the few studies and data available have shown that TB is a significant health problem requiring interventions to improve the quality of life of miners, ex-miners and surrounding communities. TB is a potential problem in the mines of Zambia and the actual burden needs to be determined. Exposure to silica as a risk factor needs further investigation.

## 1. Introduction

Zambia is one of the many countries in sub-Saharan Africa that is burdened by tuberculosis (TB). The recent Zambia National TB Prevalence Survey 2013–2014 estimated the prevalence rate of all forms of bacteriologically confirmed pulmonary TB (PTB) among those aged 15 years and above to be at 638 per 100 000 populations which is higher than the prevalence rate in high TB burden countries such as Pakistan and Nigeria [1]. Approximately 70% of people with TB in Zambia are also co-infected with HIV [2]. According to the Zambia Demographic and Health Survey 2013–2014, the prevalence of HIV was estimated to be 13.5% in Zambia [3]. Before the HIV/AIDS

epidemic in Zambia, the case notification rate of TB in Zambia in 1985 was 124 per 100 000 but the increasing HIV/AIDS epidemic in the period between 1990 and 2000 may have contributed to the increase of case notification rate to 512 per 100 000 as captured from routine facility based records countrywide [4]. The implementation of direct observed treatment short course and the TB/HIV collaborative control activities have contributed to a slight decline of TB [2]. However, the disease still remains a public health problem in Zambia [5,6].

TB being an airborne disease entails that enclosed areas such as mining sites with poor ventilation create favorable environments for TB transmission [7,8]. TB is one of the main health risks which have been found to be associated with mining [9].

Mine workers in Southern Africa including Zambia tend to have poor living and working conditions thereby having increased risk of TB and in addition working in the mines increases exposure to silica dust leading them to developing silicosis which increases their risk of developing PTB [10]. In addition, ex-miners also tend to have an increased risk of TB due to previous exposure to silica dust [11].

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In Zambia, the mining sector plays a crucial role in the economic development of the country. According to the International Council on Mining and Metals, between 2010 and 2011, the mining taxes and royalty contributed over 30% to the total government tax revenue [12]. In addition, the preliminary results from the National Labor Force Survey 2012 showed that the total formal employment from the mining and quarry industry was over 90000 [13]. These numbers do not take into account migrant workers who are sub-contracted by private companies or illegal mining workers. Therefore, it is envisaged that if the burden of TB in the mining sector is not well defined and appropriately addressed, this will have a major negative impact on the economy of the country.

The aim of this paper was to conduct a literature review on the burden of TB in the Zambian mining sector and recommend interventions that could be developed to tackle the problem of TB among miners and ex-miners, their families and surrounding communities. Some of the unpublished sources were not explicit about their methods, so it is not possible to assess their reliability. There was no data available on former miners and migrant miners in Zambia.

## 2. TB among miners in Zambia

### 2.1. Full text publications

Publications specifically focusing on TB among Zambian miners proved to be scarce. Only two online publications were identified based on the study aims. One was a cross-sectional study and the other was a retrospective study. The retrospective study conducted by Mulenga and colleagues examined the cases of silicosis and TB before (1960–1970) and after (1992–2002) the arrival of the HIV/AIDS pandemic. They found that out of 2 114 cases of silicosis and TB from 1945 to 2002, 22.7% were silicosis, 65.4% were TB and 11.9% were silicotuberculosis [14]. They also found that during the HIV/AIDS pandemic, silicosis cases decreased from 28.6% to 12.4% and silicotuberculosis increased from 37.1% to 86.1% while TB increased from 37.1% to 86.1%. The authors concluded that

although silicosis was an occupational health issue for miners in Zambia, TB was the most significant problem.

Exposure to respirable silica dust which can be generated in underground mines has been associated with TB. The risk of TB is even higher among patients who are affected with silicosis, another silica-related disease [15]. Silica-related TB is a serious condition since the risk of TB is life-long even after exposure ceases [16]. A cross-sectional study was conducted by Hayumbu *et al.* in the copper mines of Mufulira and Nkana to measure silica exposure [17]. This was part of an epidemiological study to determine the risk of respiratory diseases (silicosis, chronic obstructive pulmonary disease and TB) among Zambia miners. Their results showed that 76% of the samples collected at Mufulira mines were above the limit of quantification and had a mean respirable dust concentration of 0.992 mg/m<sup>3</sup> while Nkana mines had 69% of samples above limit of quantification and a mean respirable dust concentration of 0.868 mg/m<sup>3</sup>. Although these concentrations were below the Zambian legal limit of 1.75 mg/m<sup>3</sup>, it was higher than the United States Occupational Safety and Health Administration's recommendation of 0.5 mg/m<sup>3</sup>. In addition, their findings showed that Mufulira mines and Nkana mines had mean respirable quartz, a form of crystalline silica, of 0.143 mg/m<sup>3</sup> and 0.060 mg/m<sup>3</sup>, respectively, which were higher than the mean respirable quartz of another study in South Africa whereby the prevalence of silicosis among the gold miners was 18.3%–19.9%. They concluded that weak dust monitoring may increase the risk of nonmalignant diseases including TB among the miners. They recommended collaboration between mining companies and the Zambian government in establishing a national laboratory to provide data to develop effective dust control strategies.

### 2.2. Reports and grey literature

According to the Occupational Health and Safety Institute, the regulatory body established under the Occupational Health and Safety Act, 2010, of Zambia [18], the weighted average of the incidence rate of PTB among current mines 1994–2014 was 658 per 100000 populations. Figure 1 shows descriptive

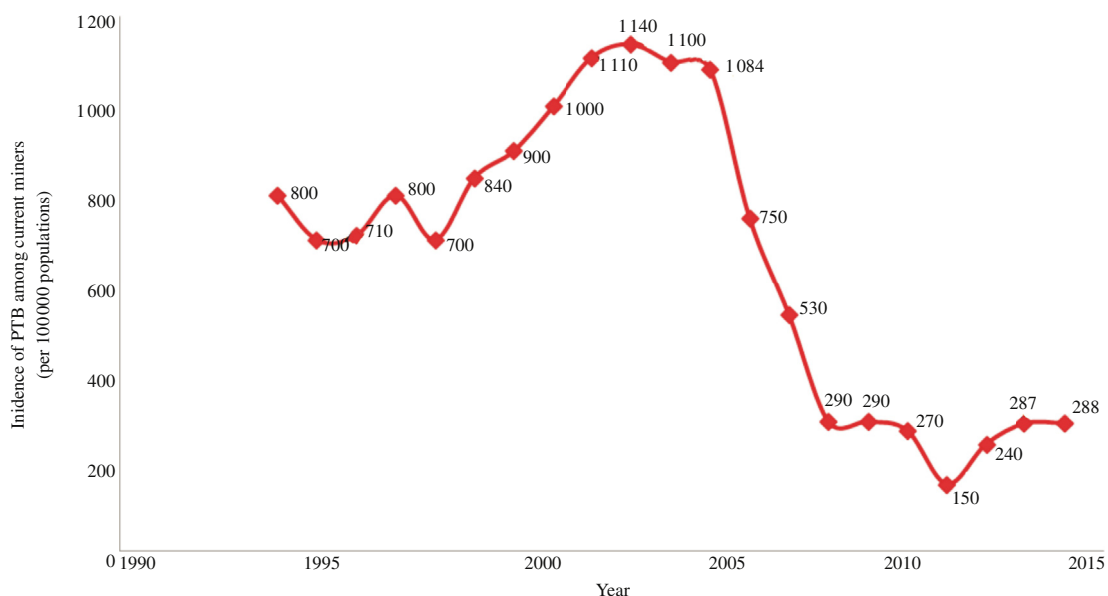


Figure 1. Trends of PTB incidence among current copper miners based on Occupational Health and Safety Institute (Kitwe, Zambia) records review.

data of a sample of the incidence rate of PTB among current copper miners. The incidence rate increased from 1994 to 2005 but since 2005, it has steadily decreased. In 2014, the incidence rate of PTB among miners in Zambia was 288 per 100 000 populations.

The TB notification rate as reported by the Zambian Ministry of Health through the National TB Control Program may be used as an indicator to determine the magnitude of the burden of TB in a specific location. The two main provinces where the mines are concentrated had the highest TB notification rates. The Copperbelt Province which holds the most copper mines in the region had a notification rate of 415 per 100 000 people in 2013 which was more than 10-fold the national TB notification rate [19].

The national prevalence survey also showed the Copperbelt Province to have the highest prevalence of bacteriologically confirmed TB of 1211 per 100 000 people in the general population [1].

### 3. Discussion and recommendations

There was limited data and research in Zambia to aid in fully determining the burden of TB in the mines and the risk factors associated with it. However, the few studies and data available show that TB is a significant health problem among miners in Zambia. Mulenga *et al.* showed that the onset of HIV in Zambia led to an increase in TB cases and the disease is a significant occupational health problem among copper miners. Similar findings have been shown in some South African studies conducted among gold miners; extensive research has shown high TB rates among current and former gold miners [20–22]. One of the factors that increase miners' susceptibility to TB is silica dust exposure. Hayumbu *et al.* showed that the mean respirable quartz at both Mufulira and Nkana mines were higher than the average quartz levels of another study whereby the miners had a high prevalence of PTB. In addition, the average total respirable dust concentrations although lower than the Zambian legal limit were above the limit recommended by other safety authorities. Another factor that has been shown to increase the risk of TB transmission is HIV. Evian *et al.* found the prevalence of HIV among a survey of 7881 miners in Zambia to be 18.1% in 2001 [23]; therefore considering the close association between HIV infection and TB, it is possible that TB/HIV co-infection among Zambia miners is important like what was found with other miners in Tanzania [24]. The combination of HIV infection and silica exposure could also increase the risk of TB among miners drastically [25].

TB being a disease normally associated with poverty, implies, poor working and living conditions also increase the risk of TB transmission especially considering that the largest number of employees in the mining industry are unskilled and uneducated individuals [26]. Interviews conducted by the Human Rights Watch among mine workers from four copper companies in Zambia revealed poor health and safety standards which were against domestic and international standards [27]. In one interview, an underground miner explained the conditions he faces, "The ventilation is very bad down here, as we drill deeper. There is lots of smoke, lots of dust, and yet we aren't given respirators. We just have a dust mask. We all have lung problems. I inhale the stuff all the time, because they don't give us a respirator; so my lungs and throat always hurt" [27].

The data from the Occupational Health and Safety Institute indicated that the burden of TB among miners who were

screened increased from 1994 to 2005 when it peaked and thereafter began to decrease steadily (Figure 1). The Occupational Health and Safety Institute is the institute established and mandated to ensure that all workers and former workers in industries including miners and former miners regularly and routinely screened for occupational health diseases including TB [18]. The reasons for the reduction in the burden were not well established, however, the reduction in mining activities in Zambia during this period could have been a factor. Further exploration and investigation is required to fully understand this. The routine national TB notification data from the National TB Programme also indicate higher TB cases from the towns that are within the Copperbelt where mining activities are concentrated than the other provinces and this fact was augmented by the findings of the national TB prevalence survey that was conducted from 2013 to 2014. Nonetheless, further research is required to fully establish the exact associations and in order to understand the magnitude and the epidemiological factors attributed to TB in the mines. However, the little evidence available has shown that the country must make it a priority to develop interventions for TB in the mines. From a human rights perspective, with mining being the economic backbone of the country, it is eminent for the government and mining stakeholders to develop strategies that could reduce the risk of TB transmission among miners and ex-miners, their families and surrounding communities. According to the Workers 'Compensation Act of 1999 of the Laws of Zambia', prospective miners found to have PTB or a history of PTB prior to employment cannot work in the mines [28]. Furthermore, those who are infected with TB on the job are removed from the mines and they are eventually discharged. Without appropriate social protection from TB illness especially among vulnerable populations, a TB episode may push families into abject poverty. TB in the mines hence has the potential to lead to significant productivity losses arising from the human capital loss for the mining sector which may be due to temporal disability or permanent loss of employment or death. The negative economic impact of TB has been documented elsewhere [29]. From a microeconomic perspective, it is a burden upon miners and their families when their livelihood ceases due to an illness [30]. These negative consequences of TB on the mining sector can be averted if the mining companies invest significantly in the control of the disease.

We recommend for Zambia to urgently adopt the World Health Organization's recommended post-2015 End TB Strategy nationally and ensure bold policies are developed accordingly in order to control TB in the mining sector. The government of Zambia took a monumental step in signing the Declaration on Tuberculosis in the Mining Industry in 2012 to eliminate TB and other occupational diseases in the mines [31]. However, the country has yet to implement the declaration which could guide it in amending some of its laws on TB and fostering partnerships with mining companies to establish more effective TB control policies. In addition, the mining companies must take responsibility in ensuring their employees are protected in the mines and take the necessary steps to assist workers who might be infected with TB. Although miners are required to undergo TB screening annually, the government in collaboration with all the mining companies must make the effort to have active case finding for miners. There needs to be effective screening programs so that miners affected by TB can be put on treatment and return to work.

Allowing miners to return to work after TB treatment might encourage them to get screened earlier. Screening programs must also make the effort to target retired or former miners since they are also at risk of TB even after silica exposure ceases [32]. Another component in controlling TB in the mines is through strengthening of the health systems. In some mining populations, effective treatment programs and health systems have significantly reduced TB rates [33]. The country must ensure that there are adequate human resources, financing, management, and information systems especially in the mining districts to address TB. Some of the mining towns have hospitals and clinics which cater to the miners and their families but not all of them have the tools to treat TB effectively, therefore, there is a need to increase the access of TB services and medicines in those health facilities [19]. Since HIV was found to be high among miners in Zambia, the risk of TB for miners is expected to be even higher. This calls for enhanced collaborative TB/HIV activities in health facilities when caring for miners.

The other component in the control of TB in the mines is by educating miners on occupational diseases especially TB and empowering miners to seek treatment. Prior to employment, miners need to be educated about the symptoms and their risk to the different occupational diseases emphasizing on TB. The safety and health procedures that are available to protect them from getting affected by any of those diseases in the mines must be highlighted. Miners could be given incentives (financial or non-monetary) to report their TB symptoms in order to increase notification rates. The feasibility and sustainability of the incentives are an area of implementation research in this context.

All of these components in controlling TB can be effective if the diverse stakeholders are able to cooperate and work efficiently. The government, mining companies and other relevant stakeholders including the affected communities must take responsibility in ensuring that the burden of TB in the mines is controlled. A coordinated multisectoral response to TB as an occupational health and safety issue is required.

#### 4. Conclusion

There is need for updated, representative epidemiological data on the magnitude of TB in the mines of Zambia. The limited evidence available in Zambia shows that TB in the mining sector is a major problem. There needs to be an aggressive focus on active case findings coupled with health system strengthening, enhanced regulatory enforcement, relevant legislative review and empowerment of miners and examiners. Adequately addressing the burden of TB in the mines could potentially lead to a healthy population of mine workers and also contribute to the reduction of TB nationally. This calls for proactive resource mobilization activities so that the availability and utilization of TB control strategies in the mines of Zambia can be improved.

#### Conflict of interest statement

We declare that we have no conflict of interest.

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