The prevalence of pulmonary tuberculosis among miners from the Karonga, Rumphi, Kasungu and Lilongwe Districts of Malawi in 2019

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Abstract

Introduction
Miners in sub-Saharan Africa have a greater risk of tuberculosis (TB) than any other working population in the world. In spite of the presence of large and vulnerable population of miners in Malawi, no previous study has aimed to assess the burden of TB among these miners. This study aimed to determine the prevalence of pulmonary tuberculosis (PTB) and health-seeking behaviour (HSB) in a population of miners in Malawi, and a range of associated factors. Our goal was to develop a method to identify missing cases of TB.

Methods
We conducted a cross-sectional study in the Karonga, Rumphi, Kasungu and Lilongwe districts of Malawi in 2019. We calculated frequencies, proportions, odds ratios (ORs) and their 95% confidence intervals (95% CIs), and used the chi-square test in STATA version 15.1 to investigate the burden and magnitude of PTB in the mining sector. Bivariate and multivariate logistic regression models were also fitted for PTB and HSB.

Results
Of the 2400 miners approached, we were able to interview 2013 (84%). Of these, 1435 (71%) were males, 1438 (71%) had known HIV status and 272 (14%) had PTB. Multivariate analysis showed that the miners performing informal mining were 50% more likely to develop PTB compared with those in formal mining (adjusted odds ratio [AOR]=1.50, 95% CI: 1.10–2.05, P=0.01). A total of 459 (23% of 2013) miners had presumptive TB. Of these, 120 (26%) sought health care; 80% sought health care at health facilities. Multivariate analysis also showed that miners who experienced night sweats were less likely to seek health care compared with those without night sweats (AOR=0.52, 95% CI: 0.30–0.90, P=0.02).

Conclusion
The prevalence of PTB was higher among miners than in the general population. Consequently, targeted TB screening programmes for miners may represent a suitable strategy to adopt if we are to end TB by 2030. Poor health-seeking behaviours among miners is worrisome and further qualitative research is necessary to understand the barriers to accessing health care in these settings.

Key Words: Mines, pulmonary tuberculosis, PTB, Malawi, health-seeking behaviour, HSB

Introduction
In 2015, there were an estimated 10.4 million new cases of tuberculosis (TB)1. In the same year, Africa contributed 2,720,000 cases of TB and 743,000 deaths2. People living with HIV accounted for 1.2 million (11%) of all new TB cases in Africa. In 2015, there were an estimated 2.1 million new HIV infections worldwide, adding up to a total of 36.7 million people living with HIV3. TB has risen markedly in sub-Saharan African nations over the past two decades. Although the main explanation for rising TB rates has been the growth of HIV, mining is also considered to be a significant determinant of countrywide variation in TB among sub-Saharan African nations4. Miners are at an exceptionally high risk of TB5. Many mineworkers are migrants; this may expose them to multiple risk factors for TB, including HIV, health care disruptions and low socioeconomic status6. Miners in sub-Saharan Africa have a greater incidence of TB than any other working population in the world (reported to be 3000–7000 cases per 100,000 miners per year in some areas), and constitutes one of the largest pools of employed men in sub-Saharan Africa7. The incidence of TB among miners is estimated to be as much as ten times higher than in the populations from which they originate. The working conditions inside mines create a high-risk environment for TB transmission, resulting from silica dust exposure, as well as confined and poorly ventilated environments that are conducive to transmission8. Migration can also disrupt TB detection and care. Miners often have multiple treatment episodes with inappropriate therapy and high default rates; these cases can lead to drug-resistant TB9. Malawi, a southern African country, has a high TB burden with an estimated prevalence and incidence of 334 and 227
The Malawi National Tuberculosis Control Program (NTP) was established in 1964 to coordinate the care facilities. The Malawi National Tuberculosis Control, the latter taking place particularly through primary health care facilities. The Malawi National Tuberculosis Control Program (NTP) was established in 1964 to coordinate the national response to the fight against TB. In general, TB services are provided free of direct costs to clients at point of care and TB is among the priority Essential Health Package (EHP) conditions. Microscopy (both light and fluorescent) remains the mainstay for the diagnosis of TB in Malawi, with radiology as an adjunctive technology where available. Gene Xpert technology has been introduced in the past few years to increase the detection of TB, particularly for clients who are sputum smear negative and HIV positive. The National TB Reference Laboratory (NTRL) provides high level diagnostic services, including solid and liquid culture, to confirm the presence of TB in selected specimens from across the country. There are two NTRLs in the country.

Study setting
There are several mining activities across the country that include the exploration of minerals such as gemstones, copper, coal, nickel, niobium, tantalum, clinker and gypsum. In total, there are 10 mining districts in Malawi. This study focuses on four high impact districts: Rumphi, Kasungu, Lilongwe and Karonga. High impact districts in this study refer to districts with high TB notification rates and districts with greater levels of mining activities. There are two types of mining populations: those working in a formal mining sector and those working in the informal sector. Formal mining refers to companies that are licensed by the government of Malawi to operate whereas the informal sector refers to mining companies/individuals who operate without a government-issued license. The burden of TB is relatively high among miners and it 10–15 times higher than that of the general public. Furthermore, miners generally have poor access to health services.

Study population
This study included individuals working in mining industries and engaged in mining activities (hereafter referred to as active miners) in the four selected high impact districts of Malawi. The study was carried out in both formal and informal mining industries.

Sample size calculation and sampling procedure
We used a TB prevalence of 1000 per 100000 population among miners, an absolute precision of 0.4%, a confidence level of 95%, and a non-response rate of 10% to estimate a total sample of 2400. The sample size was distributed equally across the four districts for convenience. From each district, 600 active miners were expected to be recruited into the study consecutively from the mining industries. We further distributed the district sample equally into formal and informal mining sectors (300 in each sector).

Data collection
All of the active miners were screened for TB and tested for HIV until the desired sample size had been reached in each district. We assessed the HIV status of miners who were already receiving TB treatment. We also conducted TB screening and HIV testing among miners with an unknown HIV status. Active miners whose TB status was unknown were screened for TB and tested for their HIV status. There were four groups within the research team: one was involved in administering the questionnaire and identifying presumptive TB cases (this group featured a research assistant/data clerk), the second group consisted of laboratory technicians who collected sputum samples from presumptive TB cases. The third team were qualified radiographers who carried out
digital X-ray screening. The digital X-ray system was mounted on a mobile van and the interpretation of X-ray results was performed by clinicians based on the results section of the client form. The fourth team member offered HIV counselling and testing to presumptive TB cases and featured HTC counsellors. The study participants were recruited at the mining industry consecutively in a convenient manner. Employers were notified of the activity days before the screening process and asked to disseminate the purpose of our visit to the employees with the help of a research assistant to clarify any issues as they arose. Those present on the day of the interview were asked to participate one after another depending on the numbers that were released at a time by the employers to avoid disruption of services for those in the formal sector. In the informal sector, those available at a particular mining settlement were requested to take part in the study. A structured questionnaire was administered to all of the study participants in the order mentioned in the list. The first part of the questionnaire captured the demographic characteristics and exposure to mining activities. Details of the study were explained to the study participants and a consent form (written in the local language) was given to the participants for them to sign. Participation in the study was voluntary. After the subjects had provided consent, we recorded a range of information, including age, sex, marital status and education level. Each subject was then given a unique identification code; this was recorded on his/her form.

The miners were asked whether they were receiving TB treatment or not at the time of the interview. If they were receiving treatment, we ascertained the category of TB and HIV status. If the HIV status was not known, the subjects were referred to the HIV counselling and testing booth to receive an HIV test. If found not to be on treatment, the subjects were asked whether they had cough, fever, night sweats for more than 1 week and weight loss. Those who admitted to all of these symptoms were treated as presumptive TB cases and proceeded with the questionnaire. Those who did not have the symptoms did not proceed with the diagnostic TB tests but were offered HIV testing services; their data were retained for analysis.

All presumptive cases were asked whether they sought any medical attention for their symptoms, where they went and what treatment they received. Patients at this stage were directed to the X-ray station where their chest radiographs would be acquired.

The study followed the national diagnosis algorithm for the diagnosis of TB and national policy when dealing with at-risk groups; X-rays were carried out in parallel with symptomatic screening for all presumptive cases. The National TB diagnosis algorithm involves the symptomatic screening of patients and those found to be presumptive cases undergo further radiographical screening for specific target groups, including health workers, prisoners, those in mines and those in high burden sites. Sputum submission for microscopy is universal for all patients and where available, the Gene Xpert system is used (as is the case with mobile TB diagnostic vans). Those found to be MTB detected Rif Negative are placed on standard TB treatments while those that are Rif Positive are either placed on a short-term regimen or individualised treatment plans. Those found to be negative on the Gene Xpert system are placed on trial antibiotics (see Figure 1).

All presumptive cases received a chest X-ray performed by qualified radiographers from a mobile van with a mounted X-ray machine. X-ray films were interpreted by a clinician stationed at this section. All of the miners also underwent sputum examination by submitting two samples: one at the time of examination and another on the morning of the following day for bacteriological confirmation. The samples and laboratory forms were labelled using the identification code given at registration. All samples were kept in cold transportation boxes and sent to the national reference laboratories within 4 days of collection. At the National Reference Laboratory, the samples were examined using microscopy and those that were smear negative were further examined using the Gene Xpert system. All clients with confirmed PTB were informed immediately and given access to treatment with anti-tuberculosis drugs at their nearest TB registration site.

Finally, the miners underwent HIV testing and counselling in order to ascertain their HIV status. The first HIV test was conducted using ‘Determine’ while confirmatory HIV tests were conducted by ‘Uni-Gold’ whenever the first HIV test was positive. Determine is a rapid test manufactured by Abbott solutions whose headquarters is in Illinois, USA. SIMILARLY unigold is also a rapid test made by Trinity Biotech whose headquarters is in Ireland (Bray-co.wicklow). HIV test results were confidential and made known only to the owner. All clients with HIV positive results were informed immediately and given access to HIV care clinics.

Data variables

We collated a wide range of data variables for analysis: screened for TB (yes/no), presumptive TB (yes/no),

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**Figure 1. Schematic showing the national diagnostic algorithm**

The figure illustrates the national diagnostic algorithm for TB screening. It includes the following steps:
- **Screening:** Presumptive TB cases undergo symptomatic screening.
- **X-ray Screening:** All presumptive cases receive chest X-rays.
- **Microscopy:** Smear-negative cases undergo further radiographical screening.
- **Gene Xpert:** Samples are examined using the Gene Xpert system.
- **HIV Testing:** All participants are offered HIV testing.
- **Treatment:** TB cases are treated according to culture results and HIV status.
Currently on TB treatment (yes/no), smear result, Gene Xpert result, X-ray findings, newly diagnosed TB (yes/no), type of TB (Sm+/Sm-), category of TB (new/retreatment), HIV test result (yes/no/indefinite/not done), type of mining population (formal/informal), type of mining industry, duration of exposure to mining activities, type of mining population (formal/informal), sex (male/female), age, marital status, level of education, religion, duration of exposure to mining activity, type of mining activity, body weight loss, fever, HSB of the miners in the event of chronic cough ≥1 week), cough for more than 2 weeks, (yes/no), sought health service (yes/no), if yes, after how many days, type of facility from where health care sought (MoH/Private/CHAM/Industrial/traditional/Other), and type of treatment received (allopathic/traditional/others).

Data management and data analysis

All data were entered into Epi-Info version 3.5.3. This is a public domain software package developed by the US centre for disease control and prevention headquarters of which is in Atlanta, Georgia. The system included: (1) a data entry module with built-in check codes; (2) a data monitoring and analysis module with built-in monitoring programs to check for duplicates, missing values and inconsistencies; and (3) a reporting module to automatically generate summary reports at the cluster and central level. We exported the data to STATA version 15.1 (Stata Corp., College Station, TX) for further data management and analysis.

We analysed data using proportions, frequencies, odds ratios (ORs), medians and interquartile ranges (IQRs). Measures of association were assessed using odd ratios and their associated 95% confidence intervals (95% CIs) and chi-square tests. We conducted both bivariate and multivariate analyses to investigate the effect of various demographic and clinical factors on the prevalence of PTB and HSB.

Age and sex were entered as a priori variables in multivariate analysis when investigating the effect of sociodemographic and clinical characteristics on the prevalence of PTB. However, age, sex, coughing, fever, night sweats and body weight loss were entered as a priori variables when multivariate modelling the effect of the sociodemographic factors on HSB. For a variable to be considered for inclusion in the multivariate model, we tested for statistical significance at P=0.2. We built the statistical model using a forward selection method and only variables that were statistically significant (P=0.05) were maintained in the model. We assessed the statistical models for sensitivity and specificity using the estat classification command. We presented the data using tables and figures as appropriate.

Ethics approval

The study was approved by the Malawi National Health Science Research Committee in Lilongwe, Malawi (protocol #: 18/01/1954). The study was also approved by The Union Ethics Advisory Board, Paris, France. We obtained individual consent from all the study participants.

Results

Characteristics of the interviewed miners

Of the 2400 miners expected to be interviewed, a total of 2013 (84%) miners took part in this study. Of these, 1426 (71%) were males; 557 (27%) were from Kasungu district while 463 (23%) were from the Rumphi district; 1079 (56%) were involved in formal mining; 570 (28%) were aged 25–34 currently on TB treatment (yes/no), smear result, Gene Xpert result, X-ray findings, newly diagnosed TB (yes/no), type of TB (Sm+/Sm-), category of TB (new/retreatment), HIV test result (yes/no/indefinite/not done), type of mining population (formal/informal), type of mining industry, duration of exposure to mining activities, type of mining population (formal/informal), sex (male/female), age, marital status, level of education, religion, duration of exposure to mining activity, type of mining activity, body weight loss, fever, HSB of the miners in the event of chronic cough ≥1 week), cough for more than 2 weeks, (yes/no), sought health service (yes/no), if yes, after how many days, type of facility from where health care sought (MoH/Private/CHAM/Industrial/traditional/Other), and type of treatment received (allopathic/traditional/others).

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more likely to develop PTB compared with those involved in formal mining (AOR=1.50, 95% CI: 1.10–2.05, \(P=0.01\)). There was an increasing trend in the adjusted OR for PTB by age (see Table 2). The AOR of PTB had either increased or decreased by an average of 14% compared with the crude OR indicating that there was a confounding effect, as shown in Table 2.

**Factors associated with health-seeking-behaviour among miners**

A total of 459 (23% of 2013) miners had one of the following symptoms: coughing, body weight loss, night sweats and fever. The median duration of cough was 7 days (IQR: 3–21). The median duration of body weight loss was 7 days (IQR: 7). The median duration of night sweats was 7 days (IQR: 4–7). The median duration of fever was 7 days (IQR: 3–7). Of the 459 subjects, 120 (23%) sought health care. Of these, 80 (67%) sought care at a facility owned by the Ministry of Health, 13 (11%) sought care at faith-based facilities, 15 (13%) sought care at private clinics, 9 (8%) sought care at other clinics and 3 (3%) sought care at clinics based within their own companies. The prevalence of HSB and its associated factors are shown in Table 3. Bivariate analysis showed that district, age, marital status and mining activities were the key factors associated with HSB. The miners from Kasungu were three times more likely to seek health care than those from Karonga (OR=3.03, 95% CI: 1.39–6.71, \(P=0.001\)). Male miners were less likely to seek health care than their female counterparts (OR=0.62, 95% CI: 0.39–0.99, \(P=0.045\)). Being aged either 45–54 years or 65+ years was associated with a higher likelihood of HSB compared with those aged 15–24 years (see Table 3). The

**Table 2**: Prevalence of pulmonary tuberculosis (PTB) and factors associated with PTB amongst the miners in Malawi in 2019

| Characteristics (n=1524) | Total number of miners (%) | Prevalence of PTB (%) | Unadjusted estimates | Adjusted estimates |
|--------------------------|---------------------------|-----------------------|----------------------|-------------------|
|                          |                           |                       | OR (95%CI) | P-value | OR (95%CI) | P-value |
| **District**             |                           |                       |            |         |            |         |
| Karonga                  | 452                       | 37 (7)                | 1.00       |         | 1.00       |         |
| Kasungu                  | 538                       | 93 (18)               | 2.71 (1.81- | <0.00 | 2.38 (1.57- | <0.00 |
| Lilongwe                 | 457                       | 92 (20)               | 3.12 (2.08- | <0.00 | 2.69 (1.77- | <0.00 |
| Rumphi                   | 454                       | 35 (8)                | 1.03 (0.64- | 0.89 | 1.14 (0.70- | 0.60 |
| **Sex**                  |                           |                       |            |         |            |         |
| Female                   | 558                       | 63 (11)               | 1.00       |         | 1.00       |         |
| Male                     | 1366                      | 194 (14)              | 1.30 (0.96- | 0.09 | 1.35 (0.93- | 0.0001 |
| **Age group (years)**    |                           |                       |            |         |            |         |
| 15–24                    | 422                       | 17 (4)                | 1.00       |         | 1.00       |         |
| 25–34                    | 547                       | 47 (9)                | 2.24 (1.27- | 0.01 | 2.35 (1.32- | 0.04 |
| 35–44                    | 475                       | 39 (7)                | 3.91 (2.16- | <0.00 | 4.16 (2.28- | <0.00 |
| 45–54                    | 268                       | 35 (6)                | 6.15 (3.48- | <0.00 | 5.68 (2.74- | <0.00 |
| 55–64                    | 126                       | 30 (5)                | 10.29 (5.55- | <0.00 | 9.60 (4.99- | <0.00 |
| 65+                      | 86 (100)                  | 38 (43)               | 14.83 (7.75- | <0.00 | 13.54 (7.13- | <0.00 |
| **Education level**      |                           |                       |            |         |            |         |
| None                     | 141                       | 32 (23)               | 1.00       |         | 1.00       |         |
| Primary                  | 1044                      | 61 (6)                | 0.61 (0.40- |         | 0.61 (0.40- |         |
| Secondary                | 669                       | 59 (30)               | 0.57 (0.23- | <0.00 | 0.57 (0.23- | <0.00 |
| Tertiary                 | 70 (100)                  | 2 (2)                 | 0.09 (0.01- |         | 0.09 (0.01- |         |
| **Marital status**       |                           |                       |            |         |            |         |
| Married                  | 1436                      | 217 (15)              | 1.00       |         | 1.00       |         |
| Separated                | 161                       | 84 (52)               | 0.84 (0.52- |         | 0.84 (0.52- |         |
| Never Married            | 327                       | 13 (6)                | 0.35 (0.21- | <0.00 | 0.35 (0.21- | <0.00 |

After adjusting for age, district and type of mining population, the male miners were 85% more likely to have PTB compared with female miners (adjusted odds ratio [AOR]=1.85, 95% CI: 1.39–2.37, \(P=0.001\)). After adjusting for age, sex and district, the miners involved in informal mining were 50% more likely to develop PTB compared with those involved in formal mining (AOR=1.50, 95% CI: 1.10–2.05, \(P=0.01\)). There was an increasing trend in the adjusted OR for PTB by age (see Table 2). The AOR of PTB had either increased or decreased by an average of 14% compared with the crude OR indicating that there was a confounding effect, as shown in Table 2.
miners that had never been married had a lower likelihood of HSB compared with those who were married (OR=0.44, 95% CI: 0.20–0.96, \(P=0.04\)). Similarly, those mining coal had a lower likelihood for HSB compared with those working in cement mining (OR=0.40, 95% CI: 0.21–0.78, \(P=0.01\)).

Multivariate analysis showed that district, age and having night sweats were the most significant factors associated with HSB. After adjusting for age, sex, coughing, night sweats, body weight loss and fever, the miners from Kasungu district were almost three times more likely to seek health care than those from Karonga district (AOR=2.64, 95% CI: 1.33–5.26, \(P=0.01\)). Furthermore, after adjusting for district, sex, coughing, night sweats, body weight loss and fever; those aged either 45–54 years or 65+ years were associated with a higher likelihood of HSB compared with those aged 15–24 years (see Table 3).

After adjusting for age, sex, district, coughing, body weight loss and fever, the miners with night sweats were less likely to seek health care compared with those without night sweats (AOR=0.52, 95% CI: 0.30–0.90, \(P=0.02\)). The AOR for HSB had either increased or decreased by an average of 11% compared with the crude OR indicating that there was a confounding effect, as shown in Table 3.

### Discussion

The PTB prevalence of 14% amongst miners is quite worrying. The prevalence of PTB was 80% higher in males and increased with increasing age. Moreover, the prevalence of PTB was 46% higher in the informal mining population. The HIV ascertainment of 71% amongst the miners was sub-optimal while the prevalence of HIV was 2% among the miners. The fact that only 26% of the miners with cough or night sweats, or body weight loss, or fever, reported having sought care is also of great concern for TB prevention efforts amongst the miners. The HSB was lower amongst males and miners with night sweats but significantly higher amongst those aged 45–54 years and 65+ years compared with those aged 15–24 years.

The prevalence of PTB amongst the miners was 14% (272/13) and was therefore amongst the highest in Malawi and other similar settings. The observed prevalence of TB was much higher than the 1014 per 100,000 reported in the 2013/2014 survey\(^3\). In other similar settings, a high prevalence of PTB has been reported in sub-Saharan African
countries. There is variation in the risk factors for PTB identified in different countries. One of the factors associated with PTB was the number of years of mining activity and was therefore similar to that reported previously for Zambia, South Africa and other sub-Saharan Africa Countries, or other similar settings. We found an increasing prevalence of PTB with an increasing duration of mining; this may have implications to exposure to silica. Consistent with other studies that have studied the effect of HIV on TB, we also found that miners with HIV were three times more likely to have PTB. We also identified sex differences in the prevalence of PTB amongst the miners. This concurs with other studies that have investigated age and sex differences associated with PTB in different populations. To our knowledge this is the first study to investigate the factors associated with PTB in miners in Malawi. Other countries have also stated that TB is a significant health problem among miners, although only a small amount of new data has arisen since the 2015 TB strategy.

Furthermore, we also found that miners involved in informal mining were almost 50% more likely to develop PTB. This could be attributed to the fact that most of these miners often operate without the use of wet methods to reduce silica exposures or operate without protective wear. In some studies in similar settings, airborne crystalline silica exposure exceeded the recommended limits for all tasks monitored with an average exposure of 16.85 mg/m³ for underground drilling by the US, National Institute for Occupational Safety and Health (NIOSH) and 0.19 mg/m³ for aboveground operations. The use of wet methods have been proposed to reduce exposures and the risk of TB and silicosis in miners involved in informal mining. Knowledge of HIV status among persons at risk of developing TB is a prerequisite for subsequent HIV care and management. Our study reported that 71% (1438/2013) of the miners had a known HIV status. The reported HIV ascertainment in our study is lower than the targets set by the UNAIDS 90-90-90 programme. Another study, conducted in Mali, also observed sub-optimal HIV ascertainment amongst miners. Further research would be important to understand the low HIV ascertainment surrounding these mines although most of the miners were males, often with poorer levels of HSB; these could be key factors contributing to these findings. Our findings suggest that the targeted HIV testing of miners would help to ensure that all the miners are offered the test and have a known HIV status.

The prevalence of PTB amongst the miners was high while the prevalence of HSB was low. The observed prevalence of PTB among the miners was higher than in the general population. Therefore, the targeted TB screening of artisanal miners may represent a key strategy to adopt if we are to end TB by 2030. Artisanal miners are those small scale miners who were never married had a higher likelihood of HSB. Furthermore, some other studies have also found that older persons had an increased likelihood for HSB than younger persons. The Malawi National Tuberculosis Control Programme should consider conducting an in-depth analysis to further understand how client-based factors, provider-based factors, perceptions, social and demographic factors, cost, social networks, biological signs and symptoms work synergistically to produce a pattern of HSB amongst the miners. The major strength of this study is its large sample size. To our knowledge, this is the first large study that has been conducted on miners in Malawi. However, there are some limitations that need to be considered. For example, this study only focused on four districts; thus, our results may not be generalisable to all 28 districts of Malawi. Furthermore, some other studies included other factors in their analyses, including the intensity of exposure to silica, smoking and alcohol intake; these factors are strongly associated with PTB. In our study, we did not consider these factors. Furthermore, this study assessed only quantitative aspects of HSB among miners. Future studies should consider conducting both qualitative and quantitative aspects of HSB among miners. We also acknowledge that our response rate at 84% was low; the WHO recommendation for response rate in TB studies is 85%.

In conclusion, this is the first study to investigate factors associated with PTB and HSB among miners in Malawi. The prevalence of PTB amongst the miners was high while the prevalence of HSB was low. The observed prevalence of PTB among the miners was higher than in the general population. Therefore, the targeted TB screening of artisanal miners may represent a key strategy to adopt if we are to end TB by 2030. Artisanal miners are those small scale miners not affiliated with any formal mining company. There is also a need for the Malawi National TB Control Programme to understand the drivers and facilitators of HSB among miners with presumptive TB. This could be achieved by conducting a qualitative study on HSB. Furthermore, the Malawi National TB Control Programme may consider performing a nationwide study so that we can obtain a nationwide understanding of the prevalence of PTB and HSB among the wider body of miners.

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