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ORIGINAL RESEARCH ARTICLE

Tuberculosis and HIV co-infection among miners at selected mining sites in Migori County, Kenya

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ABSTRACT

Tuberculosis (TB) disease is caused by acid-fast bacilli called *Mycobacterium tuberculosis*. The emergence of drug-resistant TB variants as well as co-infection with the Human Immunodeficiency Virus (HIV) have complicated treatment for TB. Kenya currently implements TB screening and HIV testing for all patients and their caretakers, regardless of their reason for visiting the hospitals. Drug resistance is tested in all HIV-positive TB suspects to guide the choice of drugs in cases of TB-HIV co-infection and minimise delays in treatment initiation. These services are, however, confined to the health facilities, and all those who do not visit the hospitals are missed. The objective of our study was to evaluate TB missed opportunities among the mining community of Osiri-Matanda gold mines in Nyatike sub-county, Migori County, Kenya. Community health outreaches were conducted in collaboration with the Ministry of Health. Demographic information was recorded for all clients consenting to the study. HIV testing was done using the HIV rapid testing kits. Sputum samples were tested in the local laboratory using Ziel-Neelsen (ZN) staining. All TB-positive outcomes were further tested using GeneXpert MTB/RIF to determine whether or not they were resistant to Rifampicin. A total of 297 participants were enrolled in the study. Among these, 49.5% were males and 50.5% were females. The youngest participant was 15 years old, while the oldest was 63 years old. A 15.5% TB prevalence was found after testing, with the age range of 35–44 having the highest prevalence at 39%. 71.7% of TB infections were male, while 28.3% were female. HIV-TB co-infections accounted for 37% of cases. None of the TB cases were RIF-resistant. This data shows that males are more at risk of TB and HIV infections than females. Collaborative health outreaches that include screening and testing for both TB and HIV could help in early detection and minimise missed opportunities.

Keywords: Tuberculosis (TB), HIV, RIF resistant, co-infection

1.0 Introduction

Kenya achieved the target of reducing TB by 20% as set by the World Health Organization (WHO) for the period between 2015 and 2020 (WHO, 2020; WHO, 2022). However, it is still ranked among the countries with the highest tuberculosis (TB) disease burden (WHO, 2020). The emergence of drug-resistant TB (DR-TB) as well as the TB-HIV co-infection further complicates the prevention, care, and treatment programs. Drug-resistant TB is a complicated and expensive

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treatment course that takes between 18 and 24 months and, at times, surpasses this in cases of extensive drug-resistant TB (XDR-TB). Patients with XDR-TB do not respond to both isoniazid and rifampicin, as well as any fluoroquinolone and any one of the second-line injectable TB drugs (Prasad et al., 2018; WHO, 2018). HIV, on the other hand, has the effect of reducing immunity for those infected (Walker et al., 2013; WHO, 2022). In order to contain the virus at a suppressed level, patients have to enroll in a lifelong antiretroviral (ARV) treatment regimen (WHO, 2022). The combination of HIV infection and TB, whether resistant or not, presents a challenging situation for patients in terms of having to deal with increased pill burden, modified nutrition, and reduced movements in order to contain the disease and prevent further spread (Tiberi et al., 2017; WHO, 2022). Lack of active case findings beyond the health setting as well as poor adherence to treatment guidelines and regimens could be conduits to enhance the spread of TB as well as HIV (Pradipta et al., 2018; Churchyard et al., 2000). TB is known to thrive and spread faster among those who have a congregate lifestyle, and the mining community is such an example (Stuckler et al., 2011; Mary et al., 2010). The mines are known to be choice destinations for lower-class populations where the experience required to be a worker is not so rigorous. In the process, the populations swell and outnumber the social amenities available, including housing. Consequently, it becomes easy to have TB spread across the population just from a single TB case. Despite the greater risk of TB in this community, it has been documented that miners are poor health seekers (Nimje et al., 2020). Since the majority of the interventions are carried out in hospital visits, miners are among the key populations most likely to be missed, which increases the risk of maintaining the TB epidemic in the community. This study evaluated and documented the active TB cases in the population, determined the type of TB, and evaluated which cases are equally co-infected with HIV.

2.0 Materials and Methods

2.1 Study site

The study was carried out at Osiri-Matanda gold mines in Nyatike Sub-County, Macalder Division, and Migori County. Osiri-Matanda is a fairly small market centre located in Nyatike subcounty, Macalder division, about 30 kilometres from Migori town. Within the area lie a number of mining holes, each hosting a group of up to 20 miners at a time, each group going down the tunnels in shifts. The site is fairly busy in terms of other economic activities, including fish trading, an open-air food and cloth market, and various retail shops. The nearest health facility is Nyatike subcounty hospital, locally referred to as Macalder, which lies approximately four kilometres from the mining site.

2.2 Study design

A cross-sectional prospective study design to evaluate the TB and HIV disease burden in the population was used.

2.3 Study population

Participants were 15 years old and older and mature minors who were living in Osiri-Matanda gold mines at the time of the study. This choice was made as per the revised HTS guideline that reduced the consent age for HIV testing to 15 years (Nascop, 2015). We also considered this category to be able to produce a sufficient amount of sputum samples as required by the

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analytical plan. The participants were sampled and enrolled in the study based on the inclusion criteria described.

2.4 Inclusion criteria

The study included:

i. All persons living or working within the study area at the time of the study and giving consent to be enrolled in the study
ii. Those 15 years and older
iii. All participants in TB treatment living at Osiri-Matanda gold mines at the time of the study were also included in the study and formed part of the final prevalence data. However, they were not eligible for sample collection and analysis since they already tested positive and were on the government-approved treatment plan with timelines for follow-up testing.

2.5 Exclusion Criteria

The study excluded:

i. Children below 15 years of age and
ii. All those who were not consenting to the study.

However, all those who were not eligible for the study equally gained from the TB and general health information that was given by the healthcare workers.

2.6 Laboratory Techniques

2.6.1 Study materials/samples

Consent forms were administered to all clients who chose to take part in the study. The TB intensified case identification form was also administered to capture the demographics as well as TB risk factors among the clients. A laboratory technologist did finger prick to collect samples for HIV testing and in cases where the first test was positive, a second prick was done to collect another sample for confirmatory HIV test. The clients were also given two sputum collection containers; one sputum mug and a 20ml Falcon tube. The sputum samples were collected simultaneously and transported to Macalder for sputum analysis via microscopy and gene expert where applicable.

2.6.2 HIV testing and counseling

HIV Testing Services (HTS) was provided to all participants at the site using the current testing algorithm. Determine^{TM} HIV-1/2 (ABBOT), an HIV screening kit, was used as the first test, and all those who turned positive were retested using the First Response HIV-1-2 RDT kit testing kit for confirmation.

2.6.3 Smear microscopy and drug resistance testing

Smears were made on new glass slides from all the sputum samples that were collected in sputum mugs. These were then air dried and stained using the Ziehl-Neelsen (ZN) staining method. Microscopy was done, and the results were documented. Where the first sample tested positive for TB, the complimentary sample that was collected in a Falcon tube was subjected to GeneXpert MTB/RIF to determine resistance to Rifampicin. The results were

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equally read, interpreted, and documented. Figure 1 represents the sputum sample analytical plan for this study.

2.6.4 Data recording and analysis

TB intensified case identification and generated the qualitative data needed for this study. These included data on coughs of two weeks or more, history of close contact with confirmed TB or chronic coughers, fever of two or more weeks, weight loss, chest pain, night sweats, as well as swellings in the neck, armpit, or joints. Quantitative data were obtained from HTS results as well as laboratory TB testing. IBM SPSS Statistics software, version 23, was used for data analysis. Mann-Whitney-U was used to analyse socio-demographic characteristics such as gender, weight, and height, while the rest, as well as TB-associated risk factors and co-morbidities, were analysed using Chi-square. All sensitive data on client TB status and drug resistance outcomes for clients were part of the data obtained and analysed in accordance with the objectives.

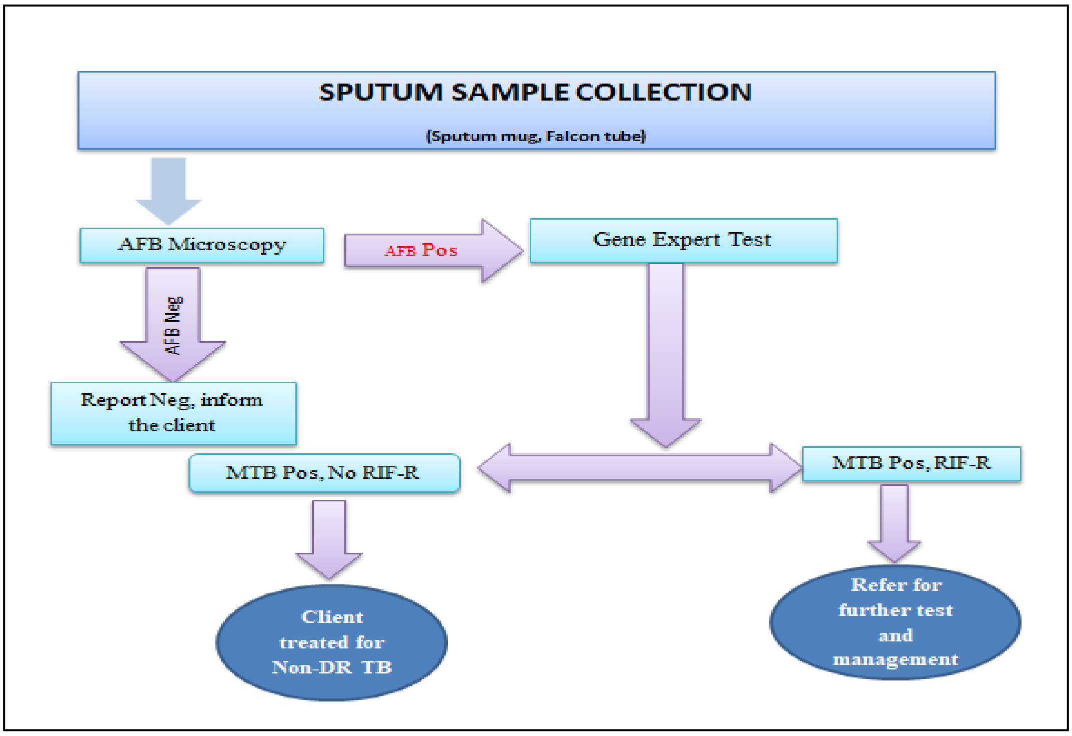

Fig 1: Sputum Sample Analytical Plan

3.0 Results

3.1 Prevalence of TB and age distribution

The prevalence of TB among miners stands at 15.5% (46/297). Half of these were new cases previously undiagnosed, while the other 50% reported they were already on treatment at the time of the study. The youngest person infected was 17 years old, while the oldest was 76 years old. Ages 35 to 44 years account for 6% (n = 297) of TB prevalence and account for up to 39% (n = 46) of all infections. This is the single-age group with the highest TB prevalence. 63% of all TB infections occur between the ages of 25 and 44. Figure 2 summarises the TB case distribution among different age groups.

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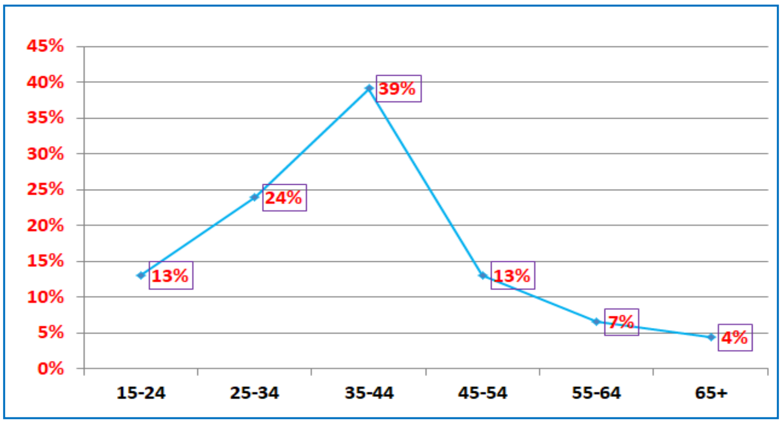

Fig 2: TB Case distribution per age groups

3.2 Prevalence of TB and Gender

Overall, 71.7% (33/46) of all TB cases in this population were males, while 28.3% (13) were females. The TB cases were distributed across all ages for both males and females. However, the peak age of infection varied, with males being 35–44 years old at 45% (15 cases), while females peak at 25–34 years old at 30.8% (4 cases). Figures 3, 4a, 4b, 5a, and 5b summarise TB cases in the overall population and among males and females of different age groups.

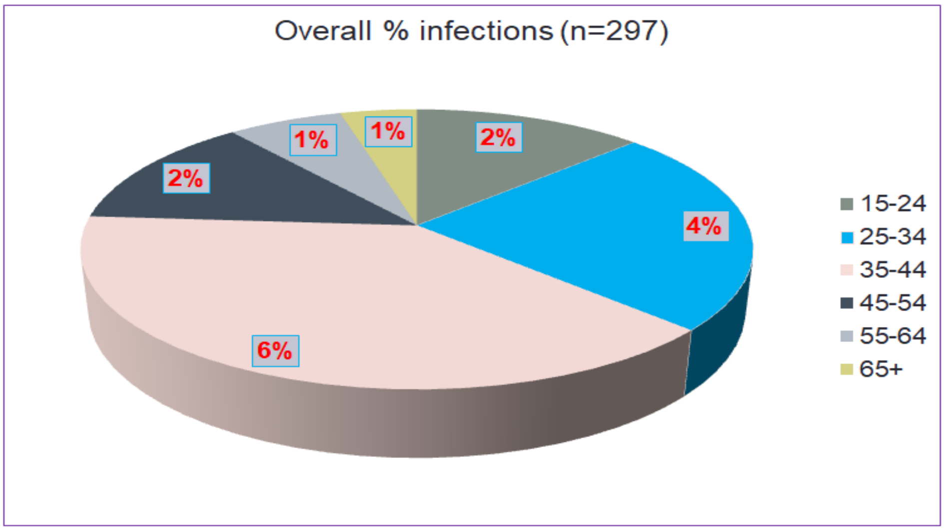

Fig 3: Overall TB infections among miners

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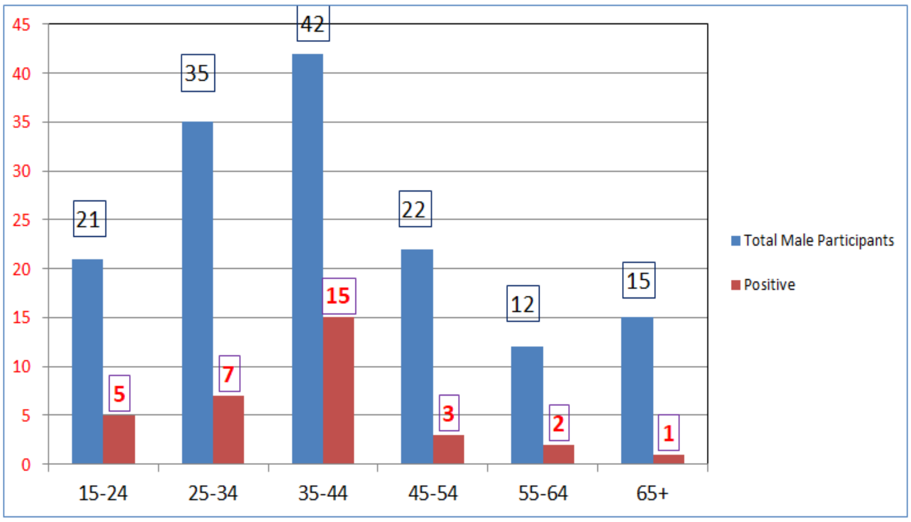

Fig 4a: Age distribution of male TB positivity

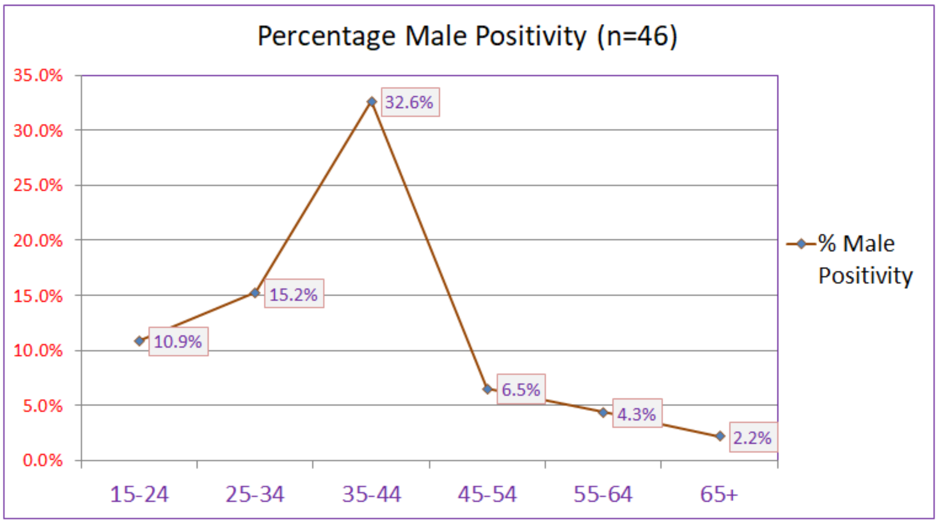

Fig 4b: Percentage male contribution to overall TB positivity by age

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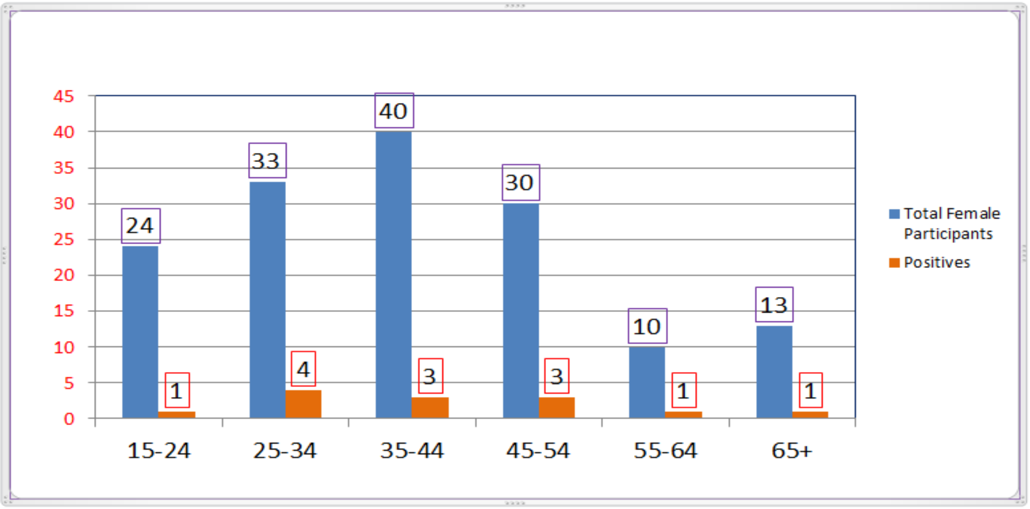

Fig 5a: Age distribution of female TB positivity

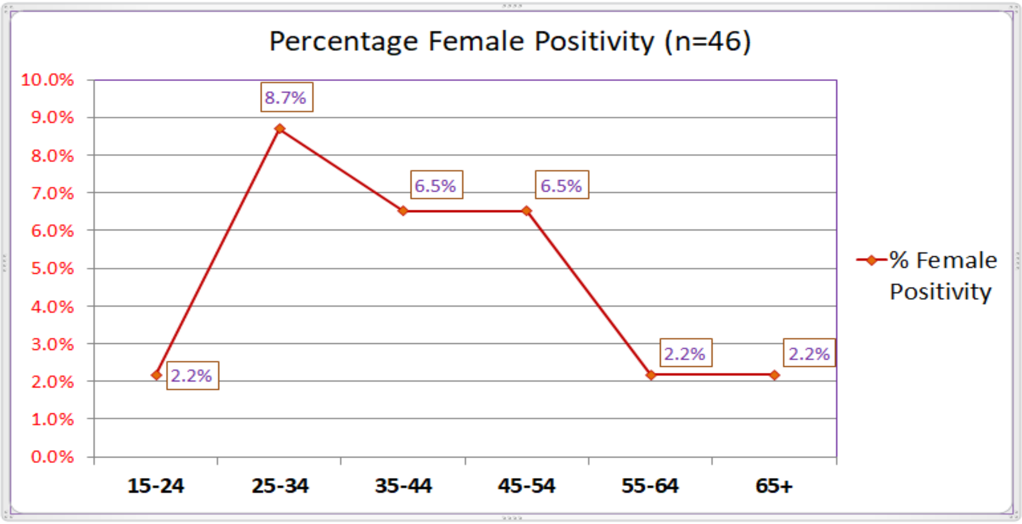

Fig 5b: Percentage female contribution to overall TB positivity by age

The males aged 35–44 presented a higher percentage of infection (35.7%) compared to females (7.5%) of the same age. It is worth noting that this age category was also the largest contributor of participants for this study, at 42 and 40 for males and females, respectively. Females showed the highest percentage of infection at ages 25–34 instead, with the least infection (4.2%) recorded at ages 15–24. Table 1 is a summary of TB infections per age category for both males and females.

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Table 1: Summary of TB infection rate per age among males and females

Sex	Ages	15-24	25-34	35-44	45-54	55-64	65+	Total
Males	Total Participants	21	35	42	22	12	15	147
	No. infected	5	7	15	2	2	2	33
	% Infections	23.8%	20.0%	35.7%	9.1%	16.7%	13.3%	22.4%
Females	Total Participants	24	33	40	30	10	13	150
	No. infected	1	4	3	3	1	1	13
	% Infections	4.2%	12.1%	7.5%	10.0%	10.0%	7.7%	8.7%

3.3 TB and socio-demographic characteristics

The p-values for gender (p = 0.001), weight (p =< 0.0001), and BMI (p =< 0.0001) were found to be significant enough in TB infections. However, our analysis of height and age proved insignificant. Table 2 is a summary of the results for key socio-demographic characteristics among the participants.

Table 2: Demographic characteristics

Characteristic	TB-, n=251	TB+, n=46	p
Age, yrs.	40.0 (21.0)	39.0 (16.3)	0.421
Gender, M/F	114/137	33/13	0.001*
Weight, kg	68.0 (13.0)	63.0 (6.0)	<0.0001*
Height, m	1.78 (0.1)	1.80 (0.1)	0.181*
BMI, kg/m2	21.4 (4.2)	18.8 (4.0)	<0.0001

3.4 TB and HIV co-infection

A total of 29 participants tested positive for HIV, while another 26 were already known to be positive at the time of the study. This gave a combined HIV positivity of 18.5% among the study participants. Of all these HIV-positive cases, 17 were equally infected with TB, giving a 37% TB-HIV co-infection rate (17/46). Like in TB prevalence, more males (76.5%) than females (23.5%) were equally co-infected with HIV, and the ages 35–44 and 25–34 presented the highest co-infections at 35.3% and 11.8% among males and females, respectively. However, there was none in the age group of ≥65 years with TB-HIV co-infection for both males and females. Males had TB-HIV co-infection in all age categories except for those 65 years and older. Females, however, had zero co-infections at ages 15–24, as well as at ages 55 and older. Table 3 is a summary of TB-HIV co-infections among males and females of different age groups.

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Table 3: Summary of TB-HIV co-infection among males and females in different age categories

Sex	Ages	15-24	25-34	35-44	45-54	55-64	65+	Total
Female	No. co-infected	0	2	1	1	0	0	4
	% co-infection	0%	11.8%	5.9%	5.9%	0%	0%	23.5%
Male	No. co-infected	1	2	6	2	2	0	13
	% co-infection	5.9%	11.8%	35.3%	11.8%	11.8%	0%	76.5%

The percentage of HIV positivity in the overall population was 18.5% (55/297). Among the 55 HIV-positive participants, 17 were positive for TB too, giving a 30.9% TB positivity among HIV-positive participants. Figure 6a shows the number of participants infected with both TB and HIV in different age categories, while Figure 6b shows the percentage contribution of different ages to the TB-HIV co-infections.

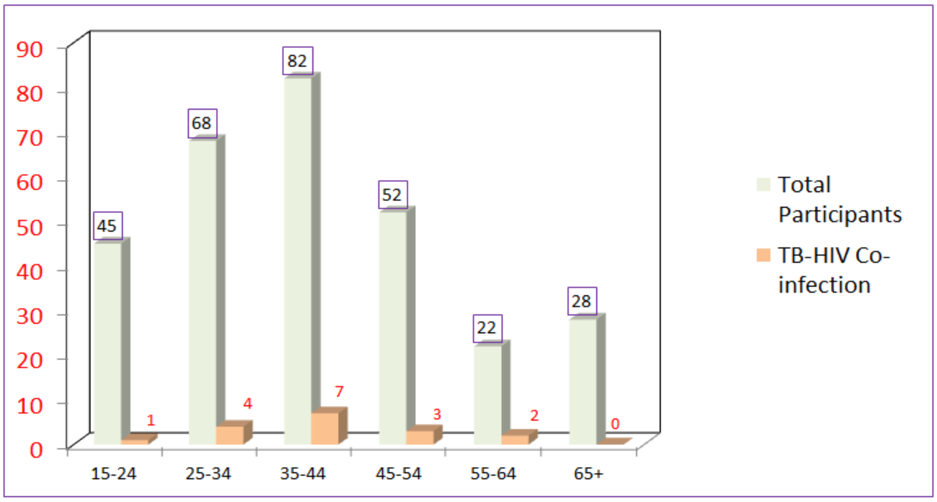

Fig 6a: Proportion of participants infected with both TB and HIV

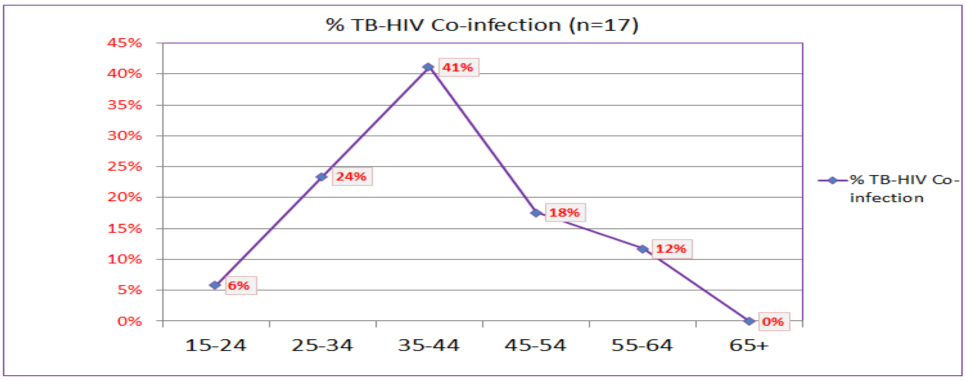

Fig 6b: Age categorization of TB-HIV co-infections (n=17)

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4.0 Discussion

The main aim of the study was to determine the prevalence of TB and HIV among the population of miners at the Osiri-Matanda gold mine in Nyatike sub-county, Migori County. The outcome was a 15.5% TB prevalence and a 37% TB-HIV co-infection rate. Half of all the TB-positive cases were newly diagnosed through this study and were living and going about their daily routines unaware of their TB status. Further, males constituted about 71.7% of all TB infections, compared to females at 28.3%. The outcome of this analysis is consistent with what the Kenya Tuberculosis Prevalence Survey got (Enos et al., 2018). In the said study, up to 809 per 100,000 cases were male. It was also reported that about 40% of all TB cases remain undetected in the community, and this has the potential to maintain the epidemic at the community level despite interventions at the health facilities. The TB testing among the participants for this study was done regardless of whether or not there were signs and symptoms consistent with TB. Therefore, with the level of positivity detected, it would be counterproductive to rely on signs and symptoms alone as a pre-requisite for TB testing since this can present missed opportunities, especially in populations that exhibit poor health-seeking behaviour like the miners.

The World Health Organisation (WHO, 2021) estimated that a person with a TB infection can in turn infect up to 15 individuals in one year if no intervention is given. With this matrix in mind, the positivity obtained in this study means that up to about 350 people can get infected from the 23 individuals who were newly diagnosed with TB. Therefore, the risk of TB in this community is significant given the constant interaction of miners around their dwellings and working areas.

As mentioned earlier, the combination of TB and HIV has been known to present quite a challenge in the management of both infections. The study got a co-infection rate of 37%, which is consistent with what DHIS2 reported for Migori County in 2021 (37.5%). In the same period (2021), 24.05% of co-infections were reported nationally, compared to 17% reported in the Kenya Tuberculosis Prevalence Survey (Enos et al., 2018)). Compared to other populations, the mining community is biased towards and tends to possess many risk factors for both HIV and TB (Musenge et al., 2018). Therefore, it is expected that the co-infection rate will be a little higher than the national or general population data.

The prevalence of TB among HIV-positive participants was found to be 30.9% (17/55). HIV has been known to be a precursor for other opportunistic infections, including TB, given the effect the virus has on the immune status of those infected (Khan et al., 2019; TIMS, 2017; Lekule et al., 2015; CDC, 2021). Studies over time have found a varied degree of TB infections among HIV-positive persons, with two different studies in Ethiopia reporting 7.2% and 18.2%, respectively (Manilal et al., 2018; Teshome et al., 2015). Another study in Tanzania (Mboya et al., 2023) reported no TB infection among HIV-positive persons. While this current study, alongside other studies referenced above, has established a strong association between TB and HIV infections, there's a need to relook at the non-association reported elsewhere and the factors predisposing the general community to TB more than the mining community (Mboya et al., 2023).

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Body mass index (BMI), weight, and gender were found to be significant factors in both TB and HIV infection. Studies have suggested a number of factors contributing to health-seeking practices, including proximity to the health facility, affordability, prompt attention, and readily available drugs, all of which contribute to up to 61% of decisions to seek health services (Akinyemi et al., 2018). Given the nature of work within the mines, it is possible that the mentioned factors could be considered by the miners, with the laxity to take up health services contributing to more males than females getting and spreading TB in the population. Additionally, a study in India reported that up to 40% of TB co-morbidities are contributed by diabetes and undernutrition (Rakesh et al., 2020), both of which weight and BMI have a direct bearing on, hence justifying the outcome of our study.

5.0 Conclusion

From the outcome of this study, we conclude that drug susceptible TB is present in this population and poses a risk to the community in terms of TB infection spread. It was also observed that individuals who tested positive for TB were not necessarily reporting any of the signs currently documented for TB, including weight loss, night sweat, fever, cough, etc. We can therefore conclude that relying on signs alone could result in missed opportunities for TB.
Lastly, our TB-HIV co-infection rate, higher than the national prevalence, is a cause and a call for more concerted effort towards the prevention and control of TB. While the local health system has largely succeeded in achieving HIV viral suppression, the existence of the co-infection tends to present additional challenges, especially among those who never turn up to health facilities for continuous TB screening except when indisposed.

6.0 Recommendations

The authors recommend a comprehensive investigation into TB medication resistance studies, including rifampicin, and advocate for regular joint health initiatives focusing on both TB and HIV.

7.0 Acknowledgements

7.1 Funding

None

7.2 General acknowledgement

None.

7.3 Ethical consideration

The study was conducted following a rigorous ethical framework. Ethical clearance was granted by the Masinde Muliro University Ethics Review Committee (ERC). Necessary licenses were acquired from the National Commission for Science, Technology, and Innovation (NACOSTI). Prior to the commencement of data collection, approvals were obtained from the Board of Postgraduate Studies at JKUAT, the Migori County Health Management Team (CHMT), and the county medical laboratory coordinator. The research team also recruited and diligently trained research assistants, equipping them with the appropriate methods and tools to ensure the fair and confidential treatment of all study participants, without any form of discrimination.

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7.4 Conflict of interest

None.

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