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SUPPORT PROJECT

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SAIOH

Southern African Institute for Occupational Hygiene (SAIOH)

MMPA
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Mine Medical Professionals Association (MMPA)

An accredited peer-reviewed journal of the Department of Higher Education and Training (DHET)

Tuberculosis (TB)

MINERALS COUNCIL SOUTH AFRICA

MASOYISE Health Programme

INDUSTRY PERFORMANCE AGAINST TARGETS (2020-2023)

ACTIVITY	MILESTONE	2020	2021	2022	2023
TB Screening	Annual TB screening (100%)	68%	75%	84%	93%
TB Incidence	Below the National TB incidence rate 5% year-on-year reduction for the TB incidence rate	195/100 000 population	221/100 000 population	241/100 000 population	223/100 000 population

TB CONTACT TRACING

TB contact tracing was implemented to stop the spread of TB in the mining industry and in the community. It involves finding the people that an infected person has been in contact with, so they can get counselling, testing and, if needed, be put on treatment.

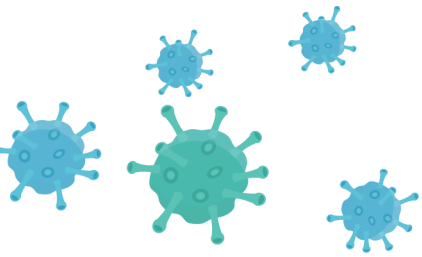
The Health and Wellness Task Team (previously known as TB Contact Tracing Task Team) helps identify TB index cases from member companies and trace identified contacts in households and communities.

World Tuberculosis (TB) Day, 24 March 2024, continues with the theme "Yes! We can end TB". TB is still one of the world's deadliest diseases and recent years have seen a worrying increase in drug-resistant TB.

ACCORDING TO WORLD HEALTH ORGANIZATION (WHO)

In 2023, 192 countries and areas with more than 99% of the world's population and TB cases reported data

WHO END TB STRATEGY: 2025 MILESTONES.



TB INCIDENCE RATE

Milestone 50% reduction 2015 - 2022

8.7% reduction 2015 - 2022

NUMBER OF TB DEATHS

Milestone 75% reduction 2015 - 2022

19% reduction 2015 - 2022

PERCENTAGE OF PEOPLE WITH TB FACING CATASTROPHIC TOTAL COSTS•

Milestone Zero in 2025

49% of people with TB face catastrophic total costs

A total of 1.3 million people died from TB in 2022 (including 167 000 people with HIV). Worldwide, TB is the second leading infectious killer after COVID-19 (above HIV and AIDS).

TB is present in all countries and age groups. TB is curable and preventable.

Multidrug-resistant TB (MDR-TB) remains a public health crisis and a health security threat. Only about 2 in 5 people with drug resistant TB accessed treatment in 2022.

US$ 13 billion is needed annually for TB prevention, diagnosis, treatment and care to achieve the global target agreed at the 2018 UN high level-meeting on TB.

Ending the TB epidemic by 2030 is among the health targets of the United Nations Sustainable Development Goals (SDGs).

WHO published a Global tuberculosis report 2023 with more insights

Front cover
Hande S Emirmahmutoğlu is a young artist based in Istanbul, Turkey, who also has a strong connection to South Africa. She works primarily in the fields of illustration, painting, and sculpture.
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Symerre Grey-Johnson: Director – Human Capital and Institutional Development (HCID) African Union Development Agency–NEPAD (Johannesburg, South Africa)
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Symerre Grey-Johnson, Guest Editor

A warm welcome to this special issue of *Occupational Health Southern Africa*, featuring research papers and reports from the Southern Africa Tuberculosis and Health Systems Support (SATBHSS) project. The SATBHSS project was designed and implemented as a multi-country, multi-disciplinary, and multi-sectoral project in response to the scourge of tuberculosis (TB) and occupational lung diseases in southern Africa. The project was launched in 2016 in Maputo, Mozambique. Seven years after implementation, this special issue showcases just a few of the project's outcomes and impacts.

The overall development objectives of the SATBHSS project were 1) to improve coverage and quality of key TB control and occupational lung disease services in targeted geographic areas of the participating countries, viz. Lesotho, Malawi, Mozambique, and Zambia, and 2) to strengthen regional capacity to manage the burden of TB and occupational diseases.[1] The former Minister of Health in South Africa, Dr Aaron Motsoaledi, once said that if TB was a snake, then the head of that snake would be in South Africa. The former United Nations General Secretary, Kofi Annan, said *"Safety and health at work is not only sound economic policy, it is a basic human right"*, which was included in the 110th Session of the International Labour Conference in June 2022,[2] as part of the International Labour Organization's (ILO's) framework of fundamental principles and rights at work.

Before the start of the SATBHSS project, more than 500 000 men and women from South Africa and the surrounding countries were reported to be working in South Africa's mines. The incidence rate of TB was 3 000–7 000 per 100 000 population and was exacerbated by the burden of occupational lung diseases.[3] Tuberculosis incidence rates were reported to be 4–7 and 3–5 times higher in Africa's and Zimbabwe's mining populations than in the general populations, respectively.[4,5]

Some of the outcomes that the project sought to achieve were the short- and long-term capacity development of government officials; strengthened TB occupational health systems; improvement in the diagnosis and treatment of occupational lung diseases; strengthened monitoring, inspection, and enforcement skills of government officials; improvement in cross-border management of TB; improvement in private sector engagement; improvement in reporting of TB and other occupational lung disease; development and review of occupational health and safety policies, laws, regulations, and standards; and improvement of occupational health services and hygiene analysis laboratory infrastructure.

Southern African countries have come a long way in addressing TB challenges in the region. The TB incidence rate in the South African mining sector is now lower than that in the general population.[6] The diagnosis of tuberculosis and occupational lung diseases has improved immensely. This special issue presents some of the innovative interventions implemented over the years. Four peer-reviewed research papers describe the role of the private sector in TB control; capacity development of occupational medical practitioners on the ILO International Classification of Radiographs of Pneumoconioses; capacitation of occupational health nursing practitioners regarding basic occupational health, audiometry, and spirometry, in partnership with KuduWave; and respirable crystalline silica dust concentrations in Zambian copper mines.

The SATBHSS project was instrumental in integrating occupational health into primary healthcare, cross-border disease surveillance initiatives, and disease outbreak control and management, e.g. for COVID-19 and cholera. Other social issues that were addressed included poverty, conflicts, nutritional supplements for TB patients, and floods. The project has contributed greatly to several African Union and international development agendas such as the African Union Agenda 2063; the Africa Mining Vision; the United Nations Sustainable Development Goals; the United Nations High-Level Political Declaration on Tuberculosis Agenda 2023; and the End TB Strategy 2030. Although we are progressing in the fight against TB, a lot still needs to be done on the continent, particularly, in the small-scale- and artisanal-mining sectors.

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Capacity development programme for the use of the ILO International Classification of Radiographs of Pneumoconioses in southern Africa: a case study from the SATBHSS and TIMS projects

N Khoza [1,2], C Chamdimba [1], P Rathebe [2], MD Masekameni [3,4], O Rikhotso [5], T Mbonane [2], M Lekganyane [6], C Sandy [1], Y Moyo [8], Q Said-Hartley [9], VS Sichizya [10], L Chikwava [11], E Tulisha [12], M Urasa [12], N Mulima [12], EM De Capitani [13], E Algranti [14], K Ngosa [15], S Adams [16], M Mafukata [3], D Moyo [4,11,17,18]

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D Moyo and S Adams are a members of SASOM

ABSTRACT

Background: The International Labour Organiza-tion (ILO) International Classification of Radiographs of Pneumoconioses (ICRP) is a method for describing and systematically recording radiographic abnormalities in the chest caused by the inhalation of dusts. The objective of this classification system is to codify the radiographic signs of the pneumoconioses in a simple, reproducible manner. The Southern Africa Tuberculosis and Health Systems Support (SATBHSS) project developed a capacity-building training programme for doctors to improve their knowledge and practical skills regarding the use of the ILO ICRP at an A-reader level.

Objective: The aim of this case study was to describe the delivery of the ILO ICRP training programme and the performances of the course participants in terms of the written pre- and post-training assessments, and the practical examination.

Methods: Eleven cohorts from seven countries participated in a nine-week A-reader training programme in the use of the ILO ICPR. Pre- and post-training assessments and a practical assessment were completed and scored. The differences in pre- and post-training assessment scores were assessed using the student's t test.

Results: One hundred and fifty-six medical practitioners underwent the training. All participants from nine cohorts in which both pre-and post-training was conducted failed the written pre-training assessment. Two participants failed the written post-training assessment and one failed the practical test. There was a notable improvement in all cohorts; the mean improvement in scores ranged from 43% to 70%. The t-test analysis showed a statistically significant improvement from the mean pre-training (25.76 ± 8.76) to post-training scores (87.90 ± 5.50) ($p < 0.01$).

Conclusion: The SATBHSS and TB in the Mining Sector in Southern Africa (TIMS) projects have contributed positively to capacity building in southern Africa. The training programme increased clinicians' confidence and ability to recognise the pneumoconioses, and improved their understanding of the ILO ICRP system. There is, however, a need to provide funding for sustainability of programmes aimed at diagnosing pneumoconioses.

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Keywords
chest X-rays, pneumoconioses, International Labour Organization, chest radiographs, mining industry, training

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INTRODUCTION

The pneumoconioses are a group of diseases resulting from the deposition of mineral dust in the lungs, which causes fibrotic lung tissue reactions.[1-3] The diagnosis is usually made on chest imaging through recognition of interstitial opacities, which may appear long before impairment of pulmonary function or symptoms manifest. The risk of disease is associated with exposure characteristics, such as cumulative dose and peak exposures. The most common types of pneumoconioses are silicosis, coal workers' pneumoconiosis, and asbestosis.

Silicosis is the most common form of pneumoconiosis in southern Africa. A recent analysis from the Global Burden of Disease study showed that the 1990–2017 age-standardised incidence rate (ASIR) of pneumoconioses increased in the southern sub-Saharan African region over the 27-year period, mainly due to an increase in silicosis incidence.[4] Several cross-sectional studies in southern Africa and South America have documented high prevalences of silicosis, ranging from 9 to 51%.[5-11] There is strong evidence that silica exposure substantially increases the risk of tuberculosis (TB), even in the absence of silicosis.[12] The association between silicosis and TB often presents difficulties in the diagnosis of silicosis.[13] The high burden of human immunodeficiency virus (HIV) infection in southern Africa reinforces the need for improving public health interventions in this area.[11,14] Human immunodeficiency virus and silicosis have a multiplicative risk for TB infection and have the potential of fuelling a TB epidemic in southern Africa.

The process of improving the interpretation and recording of pneumoconiosis radiographs evolved progressively from 1930 to the 1980 International Labour Organization (ILO) Classification System and its subsequent updating.[15] The classification system has been used to systematically describe radiographic abnormalities that occur in any type of pneumoconiosis. It is designed for classifying only the appearances seen on postero-anterior chest radiographs and has undergone eight revisions. The tool is available online but requires users to undergo training to understand the theoretical and practical concepts. Although readily available, its use remains limited in southern Africa due to inadequate training in both occupational respiratory disease recognition and diagnosis. The small numbers of trained occupational physician specialists and radiologists also limit its use. The superimposed high TB and HIV infection rates add complexity to the interpretation of radiological changes.

Globally, occupational health services are poorly developed due to inadequate legal frameworks, human capital deficits, and poor infrastructure for the prevention, diagnosis, and management of occupational diseases.[16,17] This situation is worse in southern Africa where the burdens of both TB and pneumoconioses are concentrated. A case series described by Maboso et al. (2023) revealed challenges in the health systems of southern African countries in diagnosing pneumoconiosis in the context of high TB burdens.[13] These challenges sometimes lead to under- or over-treatment of silicosis and/or TB. A missed diagnosis of silicosis and/or TB negatively affects workers' eligibility for, and access to, compensation and appropriate treatment.

To address these challenges, the African Union Development Agency-New Partnership for African Development (AUDA-NEPAD) conceptualised and developed a customised A-reader training programme based on the ILO International Classification of Radiographs of Pneumoconioses (ILO ICRP) to address the unique needs of southern Africa nations in the context of high HIV and tuberculosis burdens. The A-reader training programme was tailored for the region; assessments are based on the ILO ICRP syllabus. A-readers are certified as being trained and accredited to interpret chest X-rays (CXRs) for the presence of pneumoconiosis. A-reader training can be offered by anyone who has been trained by a certified B-reader, viz. someone who has an even higher level of proficiency and expertise in reading CXRs. B-reader experts are physicians who have successfully completed an ICRP course offered by the National Institute of Occupational Safety and Health (NIOSH).[18] All the selected trainers were subject-matter experts from academic institutions; two were B-reader certified experts.

The aim of this case study was to describe the delivery of the ILO ICRP training programme and the performances of the course participants in terms of the written pre- and post-training assessments, and the practical examination. This paper describes the development and delivery of the capacity-building training; the knowledge and practical skills gained by the participants; and the lessons learnt through the related challenges and opportunities.

METHODS

In 2018, the AUDA-NEPAD extended an invitation to occupational medicine specialists and radiologists (from the University of Cape Town and the University of the Witwatersrand in South Africa, the University of Zambia; the University of São Paulo in Brazil, the Occupational Health and Safety Institute in Zambia, and others) to undertake A-reader ILO ICRP training at the Centre of Excellence at the Occupational Health and Safety Institute (OHSI) in Kitwe, Zambia. This inaugural training proved successful, garnering enthusiasm for further training and formalisation of the programme and training material. No formal assessment of the participants was conducted during at the three-day inaugural training.

The AUDA-NEPAD subsequently submitted training invitations and letters to the permanent secretaries of the ministries of health of Lesotho, Malawi, Mozambique, and Zambia – the SATBHSS project countries – requesting nominations of medical practitioners and radiologists working in occupational health centres and district hospitals who would benefit from the A-reader ILO ICRP training. The main purpose of the training was to improve the knowledge and practical skills of the participants in the ILO ICRP, in order to strengthen capacity in the diagnosis and surveillance of occupational lung disease in the southern African region.

Subsequently, participants from additional southern African countries were added under the Tuberculosis in the Mining Sector in Southern Africa (TIMS) project, viz. Angola, Botswana, the Democratic Republic of the Congo, Eswatini, Namibia, Tanzania, South Africa, Madagascar, and Zimbabwe. A total of 156 participants, divided into 11 cohorts, participated in the training.

Eight regional training facilitators were selected and recruited, based on their qualifications and experience in the use of the ILO ICRP following the AUDA-NEPAD procurement procedures.[19] They signed contracts with the AUDA-NEPAD to support the curriculum's implementation for two years (2022 and 2023). The facilitators included occupational health specialists, radiologists, health practitioners, and B-reader experts. To improve learning and stimulate discussion during the training of Portuguese-speaking trainees, two Portuguese-speaking B-readers with experience in teaching ILO Classification courses were added to the facilitator team from September 2022.

The training sessions were delivered to 10 of the cohorts at the regional Centre of Excellence on Occupational Health and Safety (CoE-OHS) in Kitwe, Zambia, hosted by the Occupational Health and Safety Institute (OHSI) in that country.[20,21] The 11th cohort was trained in Lesotho. The CoE-OHS has nine state-of-the-art B-reading medical display monitors and computers pre-loaded with the NIOSH

reading materials. The CoE-OHS is implementing a comprehensive occupational health service in Zambia, which made it a good fit for the ILO training, catering for both theoretical and practical format requirements.

The first five days of training comprised didactic lectures in the mornings and practical ILO chest radiograph training sessions in the afternoons. Participants were given a multiple-choice question test to assess their theoretical knowledge prior to the training (baseline knowledge). They were then taught the ILO-ICRP in addition to principles of occupational health and basic chest radiology in preparation for the practical sessions. Lectures focused on the radiographic presentations of TB and HIV-related lung disease, given the high TB-HIV burden in southern Africa. This was followed by interactive sessions, using the B-reader software installed on each of the diagnostic reading systems. Participants were given selected cases to read while applying the ILO principles and practising completion of the NIOSH reading sheet. They underwent a formal assessment on Day 5 of the first week in addition to completing a post-training assessment. The formal assessment consisted of 10 CXRs selected by facilitators from the available NIOSH resources at the CoE, where participants were given 90 minutes to 1) assess the radiographic quality and presence of small and large opacities with the corresponding grading of size and profusion, and 2) assess the CXRs for pleural and other abnormalities. The assessments were scored by facilitators. Both the pre- and post-assessments consisted of 30 multiple-choice questions, which covered the training coursework. These were also marked by the facilitators.

The theory and practical examinations were executed at the end of the first week of face-to-face training. The remaining components of the curriculum were delivered over eight weeks. To be considered successful, candidates were required to obtain at least 50% in the case studies, attend at least 75% of the four Extension for Community Health Outcomes (ECHO) sessions, and attend all of the occupational health clinic visits, which were signed off by the supervising local facility medical practitioner.

For the training conducted in Lesotho, lectures were delivered in the mornings with practical CXR training sessions in the afternoons, using cases from selected occupational health facilities within Lesotho. These were compared to the ILO standard radiographs. The major challenge faced in Lesotho was the inadequate number of X-ray viewing boxes. The group was divided into two; both practical sessions and practical assessments were done in groups. The majority of participants from Lesotho were selected to attend the ILO ICRP training hosted at the CoE in Kitwe.

RESULTS

A summary of the results of the training is shown in Table 1. From September 2021 to the end of March 2023, 156 medical practitioners, divided into 11 cohorts, from seven southern African countries underwent training on the ILO ICRP, supported by the Southern Africa Tuberculosis Health Systems Support (SATBHSS) project. The first two cohorts, 1 and 2, did not undertake the written pre- and post-training assessments. Cohort 1 undertook an assessment at B-reader level; none of the participants attained a pass mark. There were no available records of the marks, since this training was administered by NIOSH trainers.

Prior to undertaking the training, all the participants in Cohorts 3 to 11 lacked the required minimum knowledge and skills required for the ILO ICRP, as shown by the failure to attain 50% in the pre-training assessment. There was notable improvement in the post-training assessment across all cohorts; the mean improvement in scores ranged from 43% to 70%. In the pre-training assessment, Cohort 3 attained the lowest score (mean of 18%), followed by Cohort 6 with a mean score of 20%. The practical assessment for Cohort 6 was scored as pass or fail for each participant; the pass mark was set at ≥ 50%. Cohort 7 attained the highest pre-training assessments mark (mean of 48%).

Cohort 9 had the highest mean post-training assessment score of 94%, while Cohort 6 had the lowest mean score of 77%. The highest mean score in the practical assessment was 73% (Cohort 3), while the lowest score was 59% (Cohort 5). The median score for the practical training was 71%, which was slightly higher than the mean score of 69%. Only one participant failed the practical assessment.

Table 2 shows the t-test analysis of the pre- and post-training assessment scores. There was a statistically significant improvement from the pre-training assessment scores ($p < 0.01$).

Table 1. Assessment scores for medical practitioners trained on the International Labour Organization International Classification of Radiographs of Pneumoconioses (N = 156)

Cohort	Participating countries (no. participants)	n	Assessment score (%)						
			Pre-training		Post-training		Improvement	Practical	
			Mean	Range	Mean	Range	Mean	Mean	Range
1	Lesotho (2), Mozambique (3), Zambia (9), Malawi (3)	17	NR	NR	NR	NR	NR	NR	NR
2	Malawi (12), Zambia (2)	14	NAC	NAC	NAC	NAC	NAC	72	60–89
3	Zambia (9)	9	18	10–24	86	61–96	68	73	60–78
4	Zambia (13)	13	27	15–51	88	77–93	61	71	61–83
5	Malawi (6), Lesotho (4), DRC (1)	11	23	7–77	91	72–100	68	59	52–68
6	Lesotho (21)	21	20	10–36	77	36–95	57	≥ 50	≥ 50
7	Malawi (6), Lesotho (11)	17	48	25–75	91	75–100	43	71	51–72
8	Mozambique (9)	9	24	7–41	93	88–97	69	70	51–85
9	Namibia (5), Swaziland (2), Zimbabwe (3), Malawi (2), Tanzania (4)	16	24	13–69	94	87–100	70	63	43–75
10	Botswana (4), Tanzania (4), Zimbabwe (4), South Africa (2)	14	25	13–44	89	30–98	64	71	61–81
11	Angola (5), DRC (4), Madagascar (4), Mozambique (2)	15	23	8–67	82	53–95	59	72	53–84

DRC: Democratic Republic of the Congo, NR: not recorded in the training records, NAC: no assessments conducted

Figure 1 shows that the median score for the post-training assessment (88%) was much higher than that for the pre-training assessment (26%) for the nine cohorts.

The course facilitators reported good aspects of the training but also noted challenges that needed to be addressed to improve the training programme. The training facilities met international standards for the delivery of the training course and were adequate for a maximum of 18 participants. However, the slide projector screen was noted to have poor image resolution and needed replacement. The facilitators recommended that work experience and previous training in occupational medicine should be a prerequisite for candidates to attend the training course as the ILO Classification of Radiographs is highly specialised. This concern applied to all the participants as they all failed to demonstrate minimum knowledge on the use of the ILO ICRP during the pre-training assessment.

DISCUSSION

This case study shows that knowledge and competence in the use of the ILO ICRP can be improved through a training programme. There was notable improvement in both the theoretical and practical assessments across the nine cohorts that underwent pre- and post-training assessments. Several researchers have noted the importance of capacity building on the ILO ICRP for medical practitioners.[22-24] The improvement was similar to that reported by Ngatu et al. (2010) who reported post-training improvements in physicians' skills on the use of the ILO ICRP.[22] They showed that, for the reading/identification of small opacities, *"there was an increase in the proportion of physicians with good specificity, from 42% to 60%"*. Tamura et al. (2022) emphasised the importance of developing and improving training methods and materials for physicians with limited experience in reading CXRs.[23] Halldin et al. (2017) noted that, due to A-readers' lack of skills in the use of the ILO ICRP, there was little agreement between the A- and B-readers (most of whom were radiologists) with respect to the quality of CXRs, the presence of pneumoconiosis, small opacity profusion, and identification of pleural disease.[24] This emphasises the need for ongoing capacity building.

Table 2. Difference between pre- and post-training assessment results (N = 9)*

Assessment	Mean (%)	SD	95% CI	p value
Pre-training	25.76	8.76	19.03–32.49	< 0.01
Post-training	87.90	5.50	83.67–92.13	

CI: confidence interval, SD: standard deviation
*Cohorts with both pre- and post-training assessment scores

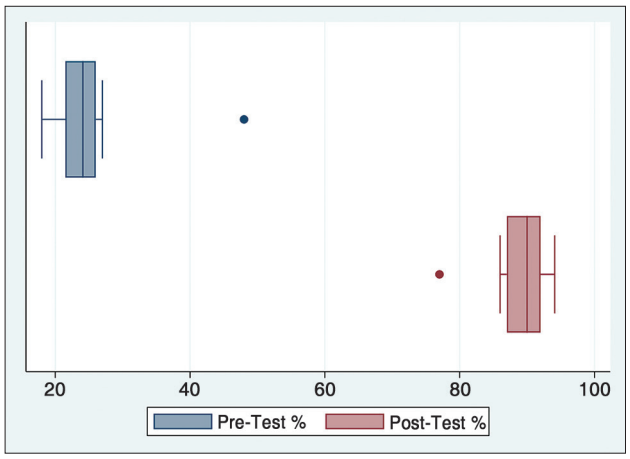

Figure 1. Median scores for pre- and post-training assessments

Taking into account the lessons learnt in the inaugural training conducted in 2018, where all participants were unsuccessful in attaining B-reader status, the SATBHSS project developed and implemented a stepwise A-reader training and mentorship programme on the ILO ICRP curriculum. The approach taken by SATBHSS is similar to that of the University of Fukkui in Japan in its development of the Asian Intensive Reader of Pneumoconiosis (AIR Pneumo) certification programme.[25] Similar to the AIR Pneumo certification programme, the SATBHSS A-reader training consists of didactic lectures, case presentations, and practical sessions developed by an expert committee of occupational physicians and radiologists. In contrast, the AIR Pneumo certification programme offers a validated proficiency examination after the training programme. However, the SATBHSS training is more intensive than the two-day Air Pneumo programme, as it comprises five-day face-to-face lectures, four ECHO sessions, occupational health clinic visits, and case presentations by candidates over a nine-week period. Almaleh et al. (2019) emphasise the importance of implementing a framework to bridge the gap between acquired curricula and required market skills, using the Align My Curriculum (AMC) framework.[26] The development process of the SATBHSS ILO ICRP curriculum was similar to that of the AMC framework.

During the SATBHSS project implementation, it was found to be necessary to develop and implement a regional ILO ICRP curriculum to harmonise, standardise, and provide a systematic approach to assist and support both participants and facilitators.[27] The curriculum outlines a stepwise approach for a nine-week training programme. It includes the training content, criteria for selection of participants and facilitators, duration of training, and assessment methods. The ILO-ICRP regional curriculum is structured in a stepwise format, comprising a one-week face-to-face training and assessment component, four virtual mentorship programmes, the reading and interpretation of 20 occupational lung disease (OLD) cases using the ILO ICRP criteria, and two one-day visits to occupational health service centres. A once-off competence certification system is adopted in the curriculum; re-certification is not required once someone has been assessed as competent. The competency certification assessment comprises the following elements: 40 single best answer questions, practical examination of 10 OLD cases and 20 OLDs case studies.

CONCLUSION

The SATBHSS and TIMS projects have contributed positively to capacity building of occupational health and safety of medical practitioners, radiologists, occupational hygienists, OHS inspectors, and law enforcement officers in southern Africa. This has increased confidence among trained clinicians in their abilities to use the ILO ICRP system and to recognise pneumoconioses. Continuous medical training on the ILO ICRP and the necessity for resources, such as the ILO standard films and online access to the NIOSH and Centers for Disease Control (CDC) websites, were emphasised. There is a need for funding for the sustainability of these programmes that are aimed at improving clinicians' recognition of pneumoconioses. Requirements include ongoing support and mentorship to participants as they apply the knowledge gained from the ILO ICRP, and the development of a community of practice and learning to raise the standard of occupational health surveillance for pneumoconioses in Africa. The regional CoE-OHS has successfully adopted the ILO ICRP and established a state-of-the-art B-reading facility with nine B-reader machines that any country can access.

KEY MESSAGES

1. Occupational health professionals without a basic occupational health and A-reader background find it difficult to master the B-reader course.
2. The capacity development of occupational health professionals in Africa is possible with appropriate training.
3. The SATBHSS and TIMS projects have contributed positively to capacity building of occupational health and safety of medical practitioners, radiologists, occupational hygienists, OHS inspectors, and law enforcement officers in southern Africa.

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DECLARATION

The authors declare that this is their work; all the sources used in this paper have been duly acknowledged and there are no conflicts of interest.

The project report was prepared in accordance with the Declaration of Helsinki and with permission from the AUDA-NEPAD.

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AUTHOR CONTRIBUTIONS

Conception and design of the study: NK, DM, CC, SA, QS-H, VSS, EA, EMDC, NM

Data acquisition: NK, KN, CC, NM

Data analysis: ML, CS, PR, DM, QS-H, MDM, TM, NK, CC

Interpretation of the data: LC, ET, LC, YM, KN, EMDC, EA, VSS, MM, LC

Drafting of the paper: DM, NK, YM, QS-H, LC, ET, MDM, EMDC, CC, CS, OR, PR

Critical revision of the paper: PR, MDM, NK, CS, CC, DM, ML, TM, OR, MM, EMDC, MU, ET, SC, QS-H

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From Suspicion to Submission – Occupational Lung Diseases in the South African Mining Industry by Dr Vanessa Govender

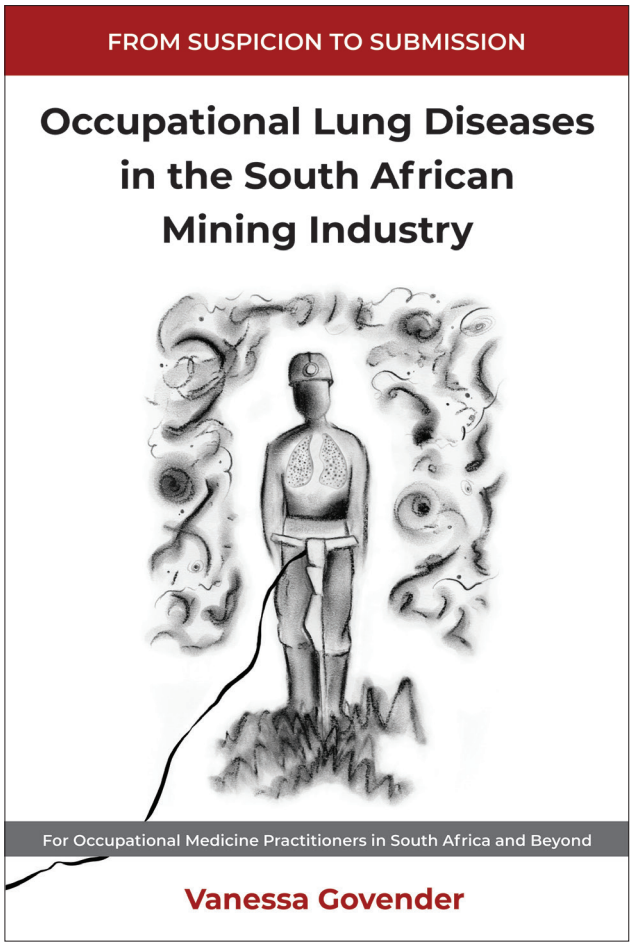
Managing occupational lung diseases from suspicion through to the prevention, investigation, diagnosis, fitness-to-work evaluation, submission for compensation and ongoing care requires in-depth clinical acumen and tools to equip the clinician. This handbook, *From Suspicion to Submission – Occupational Lung Diseases in the South African Mining Industry*, is written by Dr Vanessa Govender, a specialist in occupational medicine who has navigated a mining medicine journey spanning more than 30 years.

Published by MettaMedia, the handbook is a comprehensive overview of a range of the commonly diagnosed occupational lung diseases in the South African mining industry, enriched by insights and contributions from world-class experts.

The occupational lung diseases covered in this handbook are:

- Pneumoconioses – silicosis, asbestosis, coal workers' pneumoconiosis, mixed dust pneumoconiosis
- Tuberculosis (TB), including TB complications and post-TB lung disease
- Chronic obstructive pulmonary disease
- Systemic sclerosis
- Work-related asthma
- Lung cancer
- Asbestos-related diseases

The handbook comprises eight well-referenced chapters, which include comprehensive details regarding the compensatable occupational lung diseases, post-mortem examinations, and benefit medical examinations; the latter is presented in a practical question-and-answer format. Set within current South African occupational health laws and policy frameworks, pulmonary function and other medical tests, and the radiographic classification of the pneumoconioses, are discussed. A glossary of terms and definitions, with numerous descriptive tables and figures, insights, case studies, and key concepts provide the reader with a unique experience, making this handbook a blueprint for occupational medicine practitioners in South Africa, as well as those occupational health professionals working across its borders. The handbook's elaborative content and quick reference guides have value for non-medical professionals from the engineering, occupational hygiene, communications, human resources, and legal disciplines, and for mining executives, mineworkers, and their families.



From Suspicion to Submission – Occupational Lung Diseases in the South African Mining Industry will benefit mineworkers (current, former, and deceased) as occupational health professionals will be inspired to use science to drive policy decisions, thereby enhancing workplace practices.

This handbook is dedicated to all workers who mine – past, present, and future.

For further information, or to purchase the book, contact Dr Vanessa Govender at vanessa@masakhanehealth.co.za.

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Regional capacity development of occupational health nurses in southern Africa, focusing on audiometry and spirometry

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ABSTRACT

Background: Low- to middle-income countries (LMICs) have a high burden of noise-induced hearing loss and occupational lung diseases, which are often undiagnosed. The situation is exacerbated by a lack of skilled and experienced healthcare practitioners who can conduct the necessary diagnostic tests, according to global standards. There is a need to train more healthcare workers on theoretical and practical skills in audiometry and spirometry.

Objective: This study aimed to assess the effectiveness of a five-day practical spirometry and audiometry training course in four LMICs in southern Africa, under the Southern Africa Tuberculosis Health Systems Support (SATBHSS) project.

Methods: Ninety-one nurses participated in a five-day audiometry and spirometry training course under the SATBHSS project from 2021 to 2022. Competency tests were conducted prior to, and after the training. The competency assessment consisted of multiple-choice and short-answer questions on audiometry and spirometry. The same test was used for the pre-and post-training assessments. Practical assessments were only conducted at the end of the training.

Results: The overall mean improvement for the participants was 32%; 96% of the participants passed the post-training assessment. The mean pre- and post-training assessment scores in Mozambique were 48.31 ± 15.05 and 69.15 ± 22.66, respectively. In Malawi, the mean scores were 36.46 ± 9.40 and 89.36 ± 7.26, respectively. The improvement in scores was statistically significant for both countries ($p < 0.05$).

Conclusion: Short courses in audiometry and spirometry can significantly improve knowledge and practical skills in these areas. Countries need to scale up capacity development workshops, while implementing the basic occupational health services model, which consists of integrating occupational health into primary health services.

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southern Africa, hearing tests, respiratory function, spirometry calibration, audiometry calibration

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INTRODUCTION

Nearly 20% of the world's population live with impaired hearing, with about 5% (430 million) suffering from disabling hearing loss.[1] Approximately 2.5 billion people are projected to suffer from hearing loss by the year 2050.[2] Globally, noise-induced hearing loss (NIHL) affects approximately 5% of the world's population, and accounts for 16% of disabling hearing loss in adults.[2,3] Noise-induced hearing loss and respiratory conditions are among the most prevalent occupational health conditions in most workplaces. The World Health Organization (WHO) advocates for systematic screening for the detection of hearing loss and related ear diseases in those who are at highest risk, such as workers exposed to noise or chemicals, people receiving ototoxic medicines, and older adults.[1] The burden of hearing loss is highest in low-income countries, where there is limited access to education, medication, technology, and health interventions.[4,5]

Occupational exposures account for at least 10% of all lung diseases.[6] Chronic occupational lung diseases are among some of the most common respiratory conditions, with occupational asthma being the most common.[6] Occupational lung diseases are frequently misdiagnosed or underdiagnosed due, in part, to non-existent or inadequate health surveillance for workers.[7] In low- and middle-income countries (LMICs), there is a dearth of expertise among healthcare workers in the diagnosis of both occupational hearing disorders and occupational respiratory conditions.[8,9] This is compounded by the limited access to audiometry and spirometry services.

Southern Africa is currently experiencing a high burden of NIHL and a triple epidemic of tuberculosis (TB), human immunodeficiency virus (HIV) infection, and silicosis.[10] Competence in diagnostic skills, including audiometry and spirometry, is key to curbing the rising burden of these conditions. To this effect, the African Union Development Agency-New Partnership for Africa's Development (AUDA-NEPAD), through the Southern Africa Tuberculosis and Health Systems Support (SATBHSS) project, with funding from the World Bank, implemented a capacity-development programme in four southern African countries, viz. Lesotho, Malawi, Mozambique, and Zambia. Among other key deliverables, the project sought to train nurses in audiometry and spirometry to capacitate them to diagnose and manage occupational lung diseases and hearing loss.[11] From a regional perspective, South Africa has made good progress in the training and practice related to occupational health nursing, with the South African Nursing Council (SANC) regulating both the national university curriculum and the registration of practising occupational health nursing practitioners (OHNPs). The SANC also outlines the professional competencies of nurses.[12] Similarly, audiologists practising in South Africa are required to be registered with the South African Association of Audiologists.[13] Both registered OHNPs and audiologists are competent in conducting audiometric testing, based on training curricula in South Africa.[12-14] However, the current training offered to OHNPs and audiologists in Lesotho, Malawi, Mozambique, and Zambia is below the level of that received by professionals previously enrolled in South African universities.

Noise and respiratory hazards are common in most workplaces. Audiometry and spirometry tests are important for medical surveillance in occupational health practice. Short training in audiometry and spirometry has been shown to be invaluable in improving the competencies of nurses involved in occupational health practice.[15,16]

The objective of the study was to evaluate the knowledge and practical skills acquired by nurses who participated in an occupational audiometry and spirometry training course.

METHODS

We assessed the performance (theoretical and practical) of nurses who received audiometry and spirometry training as part of the SATBHSS project in 2021 and 2022.

Course participants

Nurses were drawn from the four SATBHSS project countries, viz. Lesotho, Malawi, Mozambique, and Zambia. Ministries of health from each of the four project countries were asked to select nurses to attend a five-day training course on occupational audiometry and spirometry. There were no specific selection criteria for the nurses; however, countries were required to send those who were working in departments that conducted audiometry and spirometry. Ninety-one nurses were selected to participate in the training.

Participants from two of the countries (Malawi and Mozambique) were assessed at the beginning of the week. All participants were assessed at the end of the week via a practical examination and a post-training theory assessment. The training records and scores of all the nurses who completed the training were reviewed. All 91 nurses who enrolled in the course completed all the training assessments.

Course facilitators

Potential facilitators were invited to submit their curricula vitae. A rigorous selection process was carried out by a panel of experts and selected facilitators were offered two-year contracts. The training was facilitated by qualified experts in the fields of occupational audiometry and spirometry. The chosen facilitators were two occupational health nurses and an occupational physician. They each had more than five years of experience in occupational health, including spirometry and audiometry.

Training programme

The nurses were trained on different occasions over two years (2021–2022). Standard training materials were used across the four countries. The audiometry training covered the fundamentals, principles, and occupational health standards of audiometry; theory of conducting audiometry; biological calibration; and practical audiometry sessions. The spirometry training consisted of fundamentals of spirometry, test validity (repeatability and acceptability), basic interpretation principles, equipment calibration and maintenance, troubleshooting, and infection control. During the practical sessions, participants took turns in performing either audiometry or spirometry testing in the presence of the other participants. Each participant repeated the tests several times, until the facilitators were satisfied with the quality. The nurses were trained using a portable Kuduwave audiometer, manufactured by eMoyo (Pty) Ltd., and a portable Minispir spirometer that was MIR Spiro Platinum spiro-ATS 2019 compliant.[17,18] Both the audiometer and spirometer had valid electronic calibrations.

The course was delivered in English (all participants had a formal tertiary education that was delivered in English), via face-to-face lectures, group discussions and practical demonstrations in Lesotho, Malawi, and Zambia. In Mozambique, a Portuguese-speaking country, training was conducted in English, using Portuguese translators. The programme consisted of two days of spirometry training and two days of audiometry training. The fifth and final day was dedicated to revision, theory assessments, and course evaluation. The number of notional training hours for the course was 32 hours.

The participants were required to complete pre-training and post-training tests, which comprised multiple-choice questions and short-answer questions about audiometry and spirometry. In 2021, no pre-training assessment was conducted. Practical assessments were conducted at the end of the training. Participants were assessed on their practical audiometry and spirometry abilities. The candidates needed to score at least 80% to pass the practical assessment. At the end of the training programme, each participant was asked to evaluate the training programme by completing an anonymous questionnaire.

The nurses' regional capacity-building programme training records were kept by the AUDA-NEPAD. We used a data proforma to extract the country of origin and individual performance results (pre- and post-training test scores).

Ethical clearance for the study was obtained from each country: Lesotho (ethics no. ID128-2018), Malawi (ethics clearance no. NCST/RTT/2/6), Mozambique (ethics clearance no. 34/CNBS/19), and Zambia (ethics clearance no. 2018-Nov-087). Permission to analyse and publish the data was obtained from the AUDA-NEPAD.

Data management and analysis

Data were entered into an MS Excel spreadsheet for cleaning and coding. Graphs and tables were generated, using STATA 17 and MS Excel. The data were analysed using paired t-tests to compare mean scores before and after the training.

RESULTS

Ninety-one nurses completed the training, most of whom were from Malawi (Table 1). The post-training assessment scores of participants who were trained in 2021 were lower than those trained in 2022. Four students failed in 2021; none failed in 2022. Participants from Mozambique and Malawi, trained in 2022, lacked foundational knowledge of audiometry and spirometry as evidenced by their failure to attain a pass mark of 50% in the pre-training assessment. There was an improvement in knowledge of the fundamentals of audiometry and spirometry, at the end of the training programme, for 96% of the course participants. All 91 participants scored 80% or more in the practical assessments.

Table 2 shows the differences in the pre- and post-training assessment scores for participants from Mozambique and Malawi. There was a statistically significant improvement in the scores for participants from both countries.

All the participants completed the evaluation forms after the training, and agreed that:

1. The course fulfilled the objectives set out in the manual/concept note.
2. The course satisfied their needs and expectations.
3. The content was presented at a level that was readily understandable.
4. Materials that were provided or presented had practical relevance.
5. The course included a variety of teaching methods that enhanced their learning.
6. The facilitators achieved a good rapport with the groups of participants.
7. There were opportunities for feedback and evaluation.
8. They were confident that they would accurately interpret spirometry and audiometry results going forward.

DISCUSSION

There was a glaring dearth of knowledge about the fundamentals of audiometry and spirometry among nurses before the training, but this had improved significantly for most of the participants by the end of the week. All the participants demonstrated satisfactory skills in performing practical audiometry and spirometry tests, and expressed confidence in performing the tests.

Capacity building in audiometry and spirometry is invaluable in improving nurses' knowledge. Short training in these subjects has also been shown by others to improve nurses' knowledge.[15,19,20] Ayuk et al. (2020) reported an improvement from pre-training test scores of 12% ($p < 0.01$) among nurses who underwent spirometry training.[15] Several other studies have demonstrated an improvement in knowledge and competence in carrying out spirometry, following short training courses of varying durations.[19,20] In cases where staff lack competence in spirometry and cannot make sense of the test results, there is often a tendency to forgo this important test. Marcy et al. (2005) found that the most common reasons for not performing spirometry by health workers were uncertainty about the impact of the test, unfamiliarity with the equipment and methods, and lack of training.[21] This accords well with our findings, where the majority of nurses lacked knowledge on spirometry before the training.

Lack of occupational health screening and diagnostic equipment is an impediment to good patient assessment and care. The nurses expressed their concerns about the lack of spirometers and audiometers at their workplaces. Similar findings were reported by Desalu et al. (2009), who found out that most physicians working at university teaching hospitals and Federal Medical Centres in Nigeria had limited access to spirometers.[22]

After the training, all the nurses expressed confidence in performing spirometry at a satisfactory level. Participants' improvement in their confidence, experience, and knowledge regarding spirometry after completing a spirometry training course was also reported by Parsons et al. in 2019.[23]

Our study was not without limitations. There were gaps in the data that were collected during the SATBHSS project implementation, including missing demographic and occupation-related data such as age, sex, work experience, and information on prior learning. The

Table 1. Assessment results of nurses trained in audiometry and spirometry

Year	Country	No. trainees	Mean scores (%)			No. failed
			Pre-test	Post-test	Difference	
2021	Malawi	15	ND	61	-	2
	Lesotho	10	ND	62	-	2
2022	Lesotho	14	ND	75	-	0
	Zambia	11	ND	81	-	0
	Malawi	28	36	89	53	0
	Mozambique	13	48	69	21	0
All		91	42	74	32	4

ND: not done

Table 2. Pre- and post-training assessment scores for participants from Mozambique and Malawi (2022)

Country	Assessment	Scores (%)				
		Mean	SD	Difference	95% CI	p value
Mozambique n = 13	Pre-training	48.3	15.1	20.8	2.0–39.7	0.0327
	Post-training	69.2	22.7			
Malawi n = 28	Pre-training	36.5	9.4	52.9	48.2–57.6	< 0.0001
	Post-training	89.4	7.3			

SD: standard deviation, CI: confidence interval

Photograph: courtesy of the AUDA-NEPAD

training sessions in 2021 did not include pre-training assessments, making it impossible to measure the improvement in knowledge or skills in that year of training. Therefore, our findings from the Mozambique and Malawi training sessions cannot be generalised to the other two countries. We consider, therefore, that this is an exploratory study that will assist in guiding future research. Despite these limitations, we have shown the benefit of training in improving nurses' knowledge about audiometry and spirometry testing. It is hoped that future studies will produce more robust conclusions and recommendations for future training.

RECOMMENDATIONS

Countries should scale up these capacity-development workshops and offer them in-house, using the critical mass of experts that were trained through the SATBHSS project. At a regional level, it is recommended to develop and implement TB and occupational health services frameworks, in order to undertake policy and legal reforms, and to improve risk-based medical surveillance and capacity building in TB and occupational lung diseases. There is an urgent need for regional implementation of the basic occupational health services model across countries. This will lead to integration of improved standards of occupational audiometry and spirometry skills that are limited in the African Union member states. The AUDA-NEPAD, academic institutions, and development and technical partners should endeavour to scale up training of occupational health and hygiene professionals on the continent.

CONCLUSION

Short courses in audiometry and spirometry can improve knowledge and practical skills in occupational health testing. The SATBHSS project has contributed to the capacity building of nurses in occupational audiometry and spirometry in Lesotho, Malawi, Mozambique, and Zambia, by creating a critical mass of skilled nurses who can train other health practitioners. The major challenges facing the participants related to the lack of audiometry and spirometry testing equipment at their workplaces. Integration of occupational health services into primary healthcare is necessary for good-quality occupational health services. The facilitators were experienced and knowledgeable, and the course was rated to be of a high standard by the participants.

KEY MESSAGES

1. Short courses offered by occupational health experts in occupational audiometry and spirometry can improve the theoretical and practical skills of nurses.
2. There is an urgent need for capacity development in occupational audiometry and spirometry in the southern African region.
3. There is a shortage of audiometers and spirometers, which are important for in-patient assessments and medical surveillance, in many health facilities in southern Africa.
4. It is critical to standardise the recording of pre- and post-training assessment scores for better comparability purposes.

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DECLARATION

The authors declare that this is their own work; all the sources used in this paper have been duly acknowledged and there are no conflicts of interest.

AUTHOR CONTRIBUTIONS

Conception and design of the study: NK, EM, MDM, PR, TM, DM
Data acquisition: NK, DM, EM, GS
Data analysis: ML, TT, NK, TM
Interpretation of the data: ML, NK, TM, VL
Drafting of the paper: NK, MDM, DM, PR, EM, GS
Critical revision of the paper: NK, EM, GS, GM, OR, TM, BS, IN, ML, PR, TT, VL, DM

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Private sector engagement in tuberculosis prevention and care in southern Africa

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ABSTRACT

Background: The engagement of the private sector in healthcare, particularly in tuberculosis (TB) prevention and care, is crucial for addressing the TB burden in high-prevalence regions, yet the understanding of the extent of private care, and how the collaboration with government works, remains limited in many countries.

Objectives: We examined the landscape of private sector engagement in TB prevention and care across high TB burden districts in Lesotho, Malawi, Mozambique and Zambia.

Methods: A sample of 251 private facilities was surveyed in a cross-sectional study. The sample encompassed for-profit clinics/hospitals, corporate clinics/hospitals, faith-based organisation/non-governmental organisation (FBO/NGO) clinics/hospitals, and stand-alone pharmacies and laboratories, with a focus on their roles, expansion trends, and collaborative efforts with the Ministry of Health/national TB programme (MoH/NTP). Respondents were asked how long the facility had been operating, if they had any collaboration with the MoH in TB prevention and care, and what that collaboration entailed (including challenges and incentives). Non-collaborating facilities were asked the reasons for non-collaboration and their intertest in collaboration, including needs, benefits, and challenges.

Results: The most common types of facilities were for-profit clinics/hospitals (41%), followed by stand-alone pharmacies (38%). Private for-profit facilities experienced rapid expansion over the past decade, with approximately 50% being registered in the last seven years. In Lesotho, 80% of for-profit hospitals/clinics collaborated with the Government, benefiting from various support mechanisms such as free TB drugs, diagnostic services, training, mentorship, and national guidelines. In Malawi, 73% of private facilities were collaborating with the MoH in TB prevention and care. There was minimal collaboration between the MoH and private facilities in TB prevention and care in Mozambique, with no implementation of the public-private mix for TB control in the surveyed districts. In Zambia, the collaboration was in its infancy, primarily involving corporate facilities, and lacked formal memoranda of understanding.

Conclusion: The results of the survey underscored the heterogeneous nature of public-private collaboration in TB prevention and care across the four countries, emphasising the need for tailored strategies to enhance collaboration, particularly in Mozambique and Zambia.

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public-private partnerships, End TB Strategy, Lesotho, Malawi, Mozambique, Zambia

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INTRODUCTION

The World Health Organization's (WHO's) End TB Strategy, developed in 2015, emphasises the need for national TB programmes (NTPs) to engage all care providers, including for-profit private healthcare providers, in order to identify and ensure early diagnosis of people with TB.[1] However, this objective has not been achieved and a significant proportion of people with TB remain unidentified, worldwide. In 2021, an estimated 10.6 million people fell ill with TB, of which 6.4 million were notified to national authorities across the world, implying that 4.2 million people with TB (40%) were not identified or reported to national authorities.[2] It is estimated that two-thirds of the 'missed' TB cases are those accessing TB treatment from private health providers that are not engaged with NTPs.[3] Several studies have shown that private healthcare providers are a first point of contact for a large number of TB patients,[4–6] with many of these private health providers offering TB care that lacks quality assurance or is

inappropriate.[4,7] A pattern has emerged where TB patients make their first contact with a pharmacist for over-the-counter sales of cough medicine or antibiotics, followed by one or more visits to a private healthcare provider and, finally, visits to a public sector TB diagnosis and treatment site.[5]

It is imperative that NTPs engage private healthcare providers if the gap (of missed people with TB) is to be closed and if patients are to access quality-assured TB services at all points of care. The engagement of private healthcare providers in NTPs has been shown to increase TB case notification and improve treatment success rates. In Nigeria, TB case notification by the private sector improved from 14% in 2016 to 26% in 2020, after a public-private mix approach was introduced in 2017.[8] In India, the contribution of smear-positive cases by non-NTP providers increased by 40% in 2003, after a similar approach was introduced.[9] Other studies have reported a high yield (47%) of TB cases referred from the private to the public sector, and an increase of treatment success rates from 50% to above 80% after engagement of the private sector.[4,9] The engagement of private healthcare providers in TB control is not only a key imperative in identifying people with TB, making early diagnoses, including universal access to drug sensitivity tests (DSTs), and improving access to quality-assured treatment, but it has also been proven to be effective in increasing TB case notification and treatment success.

Improved early access to TB diagnostic tests reduces delayed treatment, which is a major predicator of catastrophic costs to both the patient and the state. Studies have shown that individuals with catastrophic costs tend to be those who start treatment more than four weeks after onset of symptoms. Delay in diagnosis leads to prolonged hospitalisation, more expensive non-TB medication, and more frequent visits to healthcare facilities. Engaging the private sector to improve TB diagnosis has an impact on alleviating catastrophic costs incurred by families.[10]

Failure of NTPs to engage private healthcare providers increases the risk of delayed TB diagnosis and treatment, and excessive mortality and morbidity due to inappropriate treatment and increased drug resistance as a result of poor-quality treatment. It also leads to incomplete monitoring of TB services and documentation of TB data.[11] Therefore, engaging private healthcare providers can be viewed from the perspective of both improving TB service coverage and preventing 'harm' to TB patients.

This study is the first to explore opportunities for public–private partnerships in TB control in four high TB burden countries, with spill over benefits across the Southern African Development Community (SADC) region, as part of the Southern Africa Tuberculosis and Health Systems Support (SATBHSS) project, coordinated by the African Union Development Agency-New Partnership for African Development (AUDA-NEPAD) and funded by the World Bank.

The aim of the study was to assess the extent to which NTPs in four southern African countries are engaging private healthcare providers. The objectives were to identify existing collaborations by private healthcare provider type, which included hospitals and clinics, individual practitioners, pharmacies, and laboratories; and to assess the extent of collaboration, encompassing associated benefits, incentives, concerns, and challenges.

METHODS

This was a facility-based, cross-sectional study conducted in 2019 in the four southern African countries targeted by the SATBHSS project, viz. Lesotho, Malawi, Mozambique, and Zambia.

Engagement/collaboration of the private sector was defined as the establishment of a formal voluntary alliance, with agreement about reciprocal duties and responsibilities, and with expectations of benefits from working with governments in TB prevention and care. The scope of TB prevention included early diagnosis and treatment of active TB to stop infectiousness, prevention of active disease in exposed or known latently infected individuals, and infection prevention and control of TB in private healthcare facilities.[12]

Lists of health facilities were provided by the regulatory bodies in each country and were used to select private healthcare providers based on the WHO definition, viz. not-for-profit faith-based organisation (FBO) and non-governmental organisation (NGO) hospitals and clinics; for-profit hospitals and clinics, stand-alone pharmacies, and laboratories; and corporate hospitals and clinics. Dental, ophthalmologic, and optician facilities were excluded.

Stratified sampling was applied to ensure representation of all types of private providers in each country. Two districts, with both high TB burdens and large numbers of private healthcare providers, were selected in each country. Sample size was calculated using Epi Info 7.2 statistical software appropriate for cross-sectional study/survey designs. A total of 251 facilities were selected for the study: 40 in Malawi, 103 in Zambia, 55 in Lesotho, and 53 in Mozambique.

The project was approved by all countries: Lesotho (ethics clearance no. ID128-2018 and ID172-2019), Malawi (ethics clearance no. NCST/RTT/2/6), Mozambique (ethics clearance no. 34/CNBS/19), and Zambia (ethics clearance no. 2018-Nov-087).

Data collection

The MoH in each country took the lead in coordinating the data-collection process, including contacting stakeholders for interviews. Data were collected from each facility by trained data collectors, using a pre-tested, semi-structured questionnaire, based on the WHO TB prevention and care guidelines. The questionnaire, which included both closed and open-ended questions, was piloted in private healthcare facilities that were not part of the study sample. Data were collected by one team per country, which was independent of the respective Ministry of Health. The principal investigator trained the teams on the data-collection protocols, ethical considerations, and administration of the questionnaire. The questionnaire was designed and administered in English and translated when necessary.

Prior to data collection, the team identified a respondent who could provide the required information. The data collector first communicated with, and interviewed, the head of the facility. If there was a need for additional data, or the Head of the facility was unavailable, then the data-collection teams approached appropriate technical staff to complete the questionnaires.

Data analysis

Quantitative data were entered into EpiData and analysed using Stata16. The data were checked for consistency, outliers, and missing values. Qualitative methods comprised thematic analysis and triangulation. The variables of interest included availability of private providers over the years and extent of collaboration (by provider type); and perceived benefits, incentives, concerns, and challenges of collaboration between government (MoH) and private healthcare providers. Results are presented in tables and graphs, showing frequency distributions.

RESULTS

A total of 251 private facilities participated in the study. For-profit clinics/hospitals constituted 41% of all private facilities, followed by stand-alone pharmacies (38%) (Table 1).

Private for-profit facilities (for-profit hospital/clinics, stand-alone pharmacies, and stand-alone laboratories) have been showing rapid expansion in the last 10 years (Figure 1). About 50% of facilities were registered in the last seven years.

Availability and extent of collaboration

The degree of collaboration differed between the four countries. There was relatively better collaboration between the public sector NTPs and private facilities in Lesotho and Malawi than in Zambia and Mozambique. In Lesotho and Malawi, about 64% (n = 35) and 73% (n = 29) of private facilities, respectively, collaborated with government as opposed to 12% (n = 12) in Zambia and none in Mozambique.

In Lesotho, the MoH/NTP, in collaboration with development partners, provided the following for collaborating private facilities (for-profit and corporate clinics or hospitals): free TB drugs, free TB diagnostic services for referred patients, national guidelines, and reporting tools. The MoH also provided training, mentorship, and supportive supervision for TB prevention; and early diagnosis and treatment for healthcare workers, based on current guidelines/protocols and algorithms. In return, the private facilities were expected to provide quality services, and regularly report on TB care and prevention management to the MoH/NTP. The NGO/FBO hospitals/clinics (Christian Health Association of Lesotho-CHAL facilities) worked with the Government across all primary healthcare packages, including TB prevention and care.

In Malawi, there were no corporate hospitals/clinics or stand-alone for-profit laboratories. Government collaboration with private facilities (Table 2) started in the year preceding the study, after doing rapid assessments of needs and developing memoranda of understanding (MoUs). Similar to Lesotho, the NGO/FBO hospitals/clinics (Christian Health Association of Malawi-CHAM) worked with the Government across all primary healthcare packages, in general, including TB prevention and care. The MoH provides training, guidelines, quality assurance for the for-profit clinics/hospitals, including external quality assurance (EQA); free drug and laboratory equipment supply, depending on the type of facility and its need for diagnosis and treatment of TB; and infection

Table 1. Types of private facilities that participated in the study, by country (N = 251)

Type of facility	Country								
	Lesotho		Malawi		Mozambique		Zambia		All
	n	%	n	%	n	%	n	%	n
Private for-profit hospital/clinic	20	19.2	30	28.8	19	18.3	35	33.7	104
Private stand-alone pharmacy	15	15.6	6	6.3	27	28.1	48	50	96
Private stand-alone laboratory	1	16.7	-	-	1	16.8	4	66.7	6
NGO/FBO hospital/clinic	17	60.7	4	14.3	-	-	7	25.0	28
Corporate hospital/clinic	2	11.8	-	-	6	35.3	9	52.9	17
Total	55	21.9	40	15.9	53	21.1	103	41.0	251

FBO: faith-based organisation, NGO: non-governmental organisation

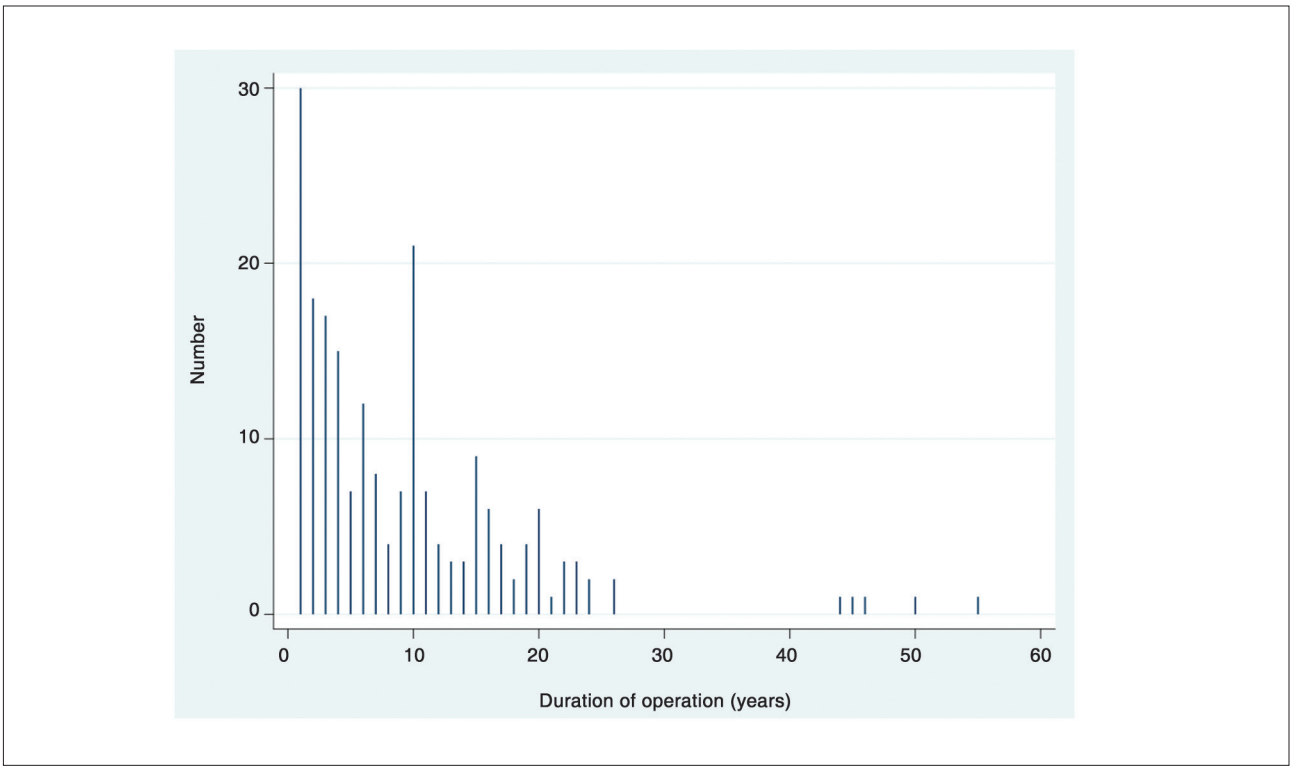

Figure 1. Registered for-profit private providers over the years (N = 206)

control guidelines and training. In return, the facilities provided free services, notified cases, and were expected to comply with agreed-upon quality standards. Clinics/hospitals that were not treatment facilities were involved by the MoH in screening and referral of presumptive cases, with sputum samples to be tested in a government facility. Most of the retail pharmacies (83%) collaborated with the MoH in screening and referral of suspected TB cases. Biannual steering committee meetings, and quarterly supportive supervision, were the main activities for monitoring the public-private mix (PPM) implementation. Data were collected through the District Health Information System (DHIS) and by District Health management teams who visit facilities every quarter to collect data from primary documents. Data from the two sources did not necessarily tally, due to incomplete recording and other data quality issues in the DHIS system.

Table 2. Engagement of private facilities in TB prevention and care, by country (N = 251)

Type of facility	No. facilities	Collaborating facilities	
		n	%
Lesotho			
For-profit hospital/clinic	20	16	80.0
For-profit pharmacy	15	0	-
For-profit laboratory	1	0	-
NGO/FBO hospital/clinic	17	17	100
Corporate hospital/clinic	2	2	100
Malawi			
For-profit hospital/clinic	30	20	66.7
For-profit pharmacy	6	5	83.3
For-profit laboratory	0	0	-
NGO/FBO hospital/clinic	4	4	100
Corporate hospital/clinic	0	0	-
Mozambique			
For-profit hospital/clinic	9	0	-
For-profit pharmacy	27	0	-
For-profit laboratory	1	0	-
NGO/FBO hospital/clinic	0	0	-
Corporate hospital/clinic	6	0	-
Zambia			
For-profit hospital/clinic	35	5	14.3
For-profit pharmacy	48	0	-
For-profit laboratory	4	1	25.0
NGO/FBO hospital/clinic	7	2	28.6
Corporate hospital/clinic	9	4	44.4

FBO: faith-based organisation, NGO: non-governmental organisation

Collaboration on TB prevention and care between the MoH and private facilities in the two districts of Mozambique was almost non-existent (Table 2). Only one corporate clinic, in one of the two districts (a tobacco company clinic) that were implementing TB/HIV collaborative activities, was collaborating with the human immunodeficiency virus (HIV) department.

Zambia had just started the process of collaboration between the MoH/NTP and private providers of TB care. Few private facilities, the majority of which were from corporate facilities (44%), had started collaborating in some form of early diagnosis, treatment, and/or referral. The collaborative activities were underway without any MoU and entailed the provision of free drugs or laboratory supplies by the MoH, depending on the capacity of the facility, in exchange for free treatment, referral linkage for diagnosis (GeneXpert test, etc.), and reporting by the private providers.

Data from the sample facilities for 2018 (collected in 2019) indicated that large numbers of patients were tested for, and diagnosed with, TB in private facilities in Lesotho and Malawi.

Challenges, incentives, benefits, and concerns of collaboration

Table 3 outlines the main responses of healthcare workers in private facilities related to working with the MoH/NTP. Challenges included limited incentives, weak governmental monitoring of the utilisation of free drugs and equipment provided to private healthcare providers, and lack of trust between the private sector and government.

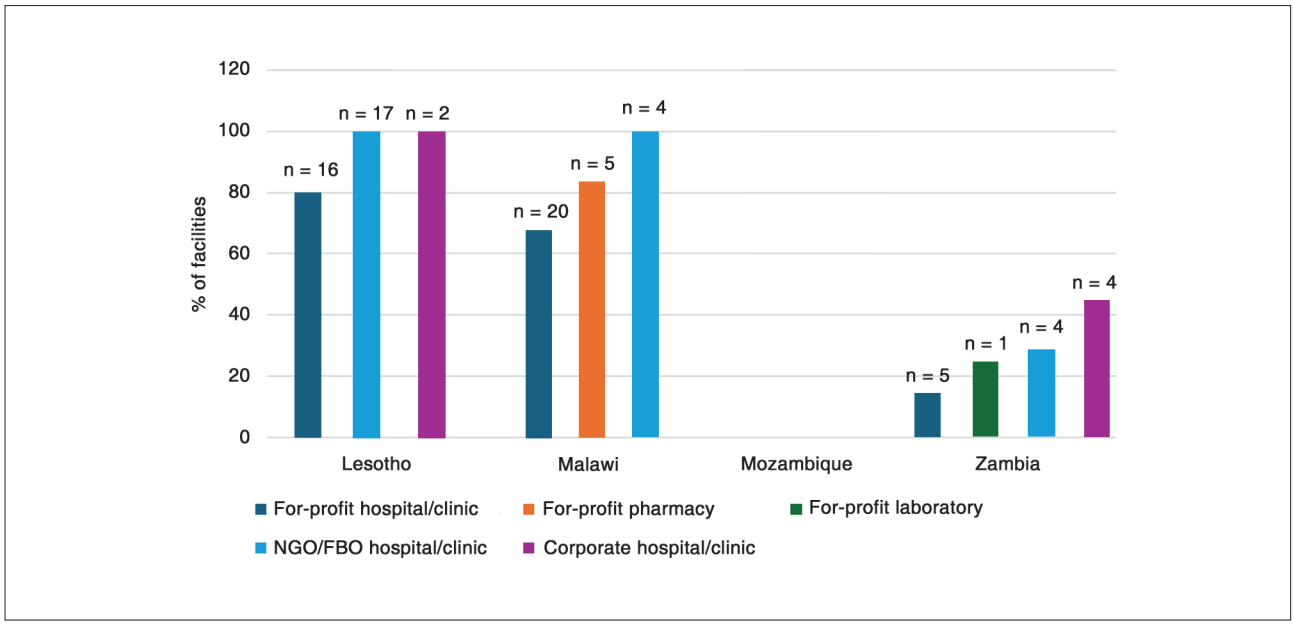

Figure 2. Private health facilities engaged with government in each of the four countries

FBO: faith-based organisation, NGO: non-governmental organisation

Table 3. Challenges, incentives, and benefits of collaborations

Challenges for collaborating facilities
• Concern about the negative attitudes of providers in government facilities towards patients referred from private for-profit facilities
• Patients in private facilities are reluctant to go to public facilities for tests or treatment for several reasons, such as stigma, privacy, provider's attitude, long queues, etc.
• Lack of infection control guidelines and training in Malawi
• Mistrust between government and private sector
• Stock-outs of TB drugs (isoniazid (INH), in particular) and laboratory reagents in Lesotho
• Delay in turnaround time for laboratory results, due to slow sample transportation system and paper-based reporting in Lesotho
Incentives for both collaborating and non-collaborating facilities
• Perceptions (notably in small clinics) that collaboration with the MoH improves visibility/image in the community, leading to increases in the numbers of patients seeking services in the facility, which could boost revenue
• Additional incomes that could be generated from diagnosis and treatment of co-morbidities of TB patients and their contacts
• Availability of TB diagnostics and drugs could attract customers
• Collaboration is seen as an opportunity to retain patients who do not want to go to public facilities. It is thought to improve patients' need in getting services in one place, where they want them
Benefits for both collaborating and non-collaborating facilities
• Reduced overcrowding in government facilities, especially hospitals
• Improved access to services and ease of follow up, as private facilities are widely spread and close to communities
• An opportunity to minimise delays in diagnosis and treatment, and increase detection of missing TB cases
• Access to training on current protocols/guidelines
• Supportive supervision to improve technical capacity of providers in TB prevention and care
• Strong desire to collaborate with government (MoH) across all types of private facilities
Concerns for both collaborating and non-collaborating facilities
• Limited commitment from government to translate the process into action, and to sustain the collaboration
• Mistrust between private sector health providers, officials in the MoH, and health facilities
• Burden of managing TB cases on clinic staff, especially data handling and follow up of TB cases
• Free service policy of government: need to charge patients consultation fees even though drugs or diagnostics are provided by government
• Burden of contact and defaulter tracing as patients visiting private facilities are widespread, geographically
• Inconsistent supply of drugs, diagnostics, infection control equipment, and consumables

MoH: Ministry of Health, TB: tuberculosis

Table 4. Reasons for non-collaboration between private healthcare providers and Ministry of Health/ national TB programmes

Lack of engagement
• NTPs have not come forth to engage private sector facilities about issues of TB
• No visits or approaches from the NTP
• The private sector's limited awareness of the government TB strategy
• Lack of interest from government
Lack of trust
• Private healthcare providers viewed by NTP/MoH as adversaries
• Perception among MoH/NTP experts that TB prevention and care is the responsibility of public health facilities
• Neglect or lack of trust of private healthcare providers by government
• Hard boundaries between the private and public sectors

MoH: Ministry of Health, NTP: national TB programme, TB: tuberculosis

Table 5. Recommendations for collaboration between private healthcare providers and Ministry of Health/national TB programmes

Recommendation
• Involvement of private sector healthcare providers in training and access to guidelines, protocols, and algorithms to enhance technical capacities in TB prevention and care
• Change of attitudes of NTP/MoH towards private healthcare providers
• Supply of drugs, diagnostic and infection control equipment, and consumables in return for reduction in TB treatment cost
• Data recording and reporting tools to improve patient tracking and referral
• NTP visits to private facilities to provide supportive supervision and monitoring for quality improvement

NTP: national TB programme, TB: tuberculosis

Reasons for non-collaboration of private healthcare providers with the Ministry of Health/national tuberculosis programmes

The most common reasons put forward by private healthcare providers for not collaborating with (MoH)/NTPs were lack of engagement, interest, and trust on the part of the respective Government. The reasons for non-engagement expressed by private healthcare providers for non-collaboration are outlined in Table 4.

Needs of private healthcare providers to collaborate with Ministry of Health/national TB programmes

Non-collaborating private healthcare providers expressed their willingness to collaborate with MoH/NTPs. The main responses about collaboration are shown in Table 5.

DISCUSSION

The rapid expansion of the private sector, its increasing population coverage and geographical spread, and its choice as a first point of contact for many patients (poor and rich) should be seen as an opportunity to engage the sector in TB prevention and care.[13,14] Most respondents in our study stressed the needs and desire for, and benefits of, collaboration with governments in TB prevention and care, and hoped to see this collaboration implemented. They attested that many patients chose to get access services from private facilities. Therefore, strengthening the prevention, diagnostics, and care value chains of these facilities, by partnering with government, is a sustainable solution to increase TB patients' access to quality-assured services. Engaging private healthcare providers also leads to an increase in case notifications through systemic, scalable, and innovative approaches, strengthening of regulatory systems, and use of new information technologies.[5] The choice that people make about where to source services needs to be respected, and is an opportunity to provide the necessary care through collaborations between governments and the private sector.

The collaboration between the private and public sectors in TB prevention and control is absent or in its infancy in Mozambique and Zambia. The collaboration in Malawi is at an early stage as the model of engagement unfolds. Use of appropriate models of engagement, taking into consideration the diversity of private providers and their business models; the health systems context within each country or setting; and analysis of the challenges, benefits, incentives, concerns and risks, on both the side of government and the private sector, is critical for a sustained and impactful collaboration.[13-16]

There is a need for meetings and discussions between the private and public sectors, which should include other stakeholders, such as development partners and professional associations, to refine and enhance implementation strategies, agree on working modalities, and draft MoUs between the two sectors in each country. Public awareness about the availability of TB services in private facilities, using different media, is an important step that should be implemented at the initial stage of engagement.[13]

In collaborating facilities, the issue of incomplete records and other data-quality issues, and the burden of data recording and reporting, were identified as challenges that affect case notification and patient tracking. Stock-outs of drugs and reagents was another challenge that affects service delivery. Establishing a system that addresses all the value chains of service delivery, in a particular facility, is essential for impactful and quality-assured service delivery.[7-9,17]

The limited engagement of private pharmacies in the three countries is a missed opportunity for TB screening and referral, because they are one of the first contact points for presumptive TB cases. This is consistent with practices in other settings, despite the WHO and the International Pharmaceutical Federation having issued such recommendations in 2011. Engaging the private sector is imperative to identify missed TB cases, and to ensure that everyone has access to quality-assured TB treatment that is affordable.[8,18,19]

Study strengths and limitations

This is the first multi-country study in southern Africa to assess the extent to which NTPs are engaging private healthcare providers. The strength of the study lies in the comparative nature of the findings across the four study countries. The findings offer insight into what NTPs can learn from each other, given the variation in the degree to which private sector healthcare providers are involved in TB prevention and control. Other countries in the region and the continent can benefit from the findings about planning, implementation, monitoring and evaluation of public private partnerships in TB prevention and care.

The limitations of the study include information bias. Some key informants who knew the details of the MoU with government had an interest in providing positive feedback, even in cases where the MoU may have lapsed or was not well implemented. Additionally, the lack of data on the perspectives of MoH/NTP and healtcare providers in government prevented triangulation to validate some of the findings in this study.

Recommendations

Governments' clear and robust plans for collaboration with all types of private healthcare providers will scale up the provision of TB care. There is an urgent need for governments to include private healthcare providers in TB care training, to improve the quality of TB services offered by the private sector. There is also a need to foster trust and improve communication between governments and private healthcare providers. Government collaboration with private healthcare providers can reduce the gap of the missing people with TB. These tend to be people who seek services in the private sector and are, therefore, not included in national databases.

CONCLUSION

Private healthcare providers' engagement/collaboration in TB prevention and care in the four countries is heterogeneous, and ranges from non-existent or limited in Mozambique and Zambia, to progressive in Lesotho and Malawi. This is in contrast with the desire expressed by private service providers to work with government/MoH in all study countries. Retail pharmacies were engaged in TB notification only in Malawi. Strategic engagement of the private sector is essential to improve access and use of quality-assured TB prevention and care services, taking the associated challenges, benefits, concerns, and risks into consideration.

KEY MESSAGES

1. Trust is a major determinant of government collaboration with private healthcare providers; where trust is lacking, there is limited collaboration between the parties.
2. Where private healthcare providers recognise the value in collaborating with government, the mechanisms for such collaboration are lacking or weak.
3. There are limited or zero incentives for private sector contributions to TB management in project countries.
4. None of the project countries engaged private retail pharmacies except in Malawi; these pharmacies have proven to be the most difficult for government to engage with.

AUTHOR CONTRIBUTIONS

Conception and design of the study: NK, CC., MDM, OR, TM, BS, TM, ML, WH, TT, VL, DM, PR
Data acquisition: NK, MDM, OR, TM, BS, TM, ML, WH, TT, VL, DM, PR
Data analysis: NK, MDM, OR, TM, BS, TM, ML, WH, TT, VL, DM, PR
Interpretation of the data: NK, MDM, OR, TM, BS, TM, ML, WH, TT, VL, DM, PR
Drafting of the paper: NK, MDM, OR, TM, BS, TM, ML, WH, TT, VL, DM, PR
Critical revision of the paper: NK, MDM, OR, NF, TM, BS, TM, FN, ML, WH, TT, VL, DM, PR

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DECLARATION

The authors declare that this is their own work; all the sources used in this paper have been duly acknowledged and there are no conflicts of interest.

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A systematic review of respirable dust and respirable crystalline silica dust concentrations in copper mines: guiding Zambia's development of an airborne dust monitoring programme

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ABSTRACT

Background: Workers in copper mines are exposed to respirable dust (RD) and respirable crystalline silica (RCS), which could lead to the development of silicosis. With the expected increase in copper production in the next two decades due to the world's green energy pathway, the number of miners exposed to RCS and incidents of exposure exceeding the recommended occupational exposure and other limits may increase. However, data for RD and RCS concentrations in the copper mining industry are limited.

Objective: The objectives of this study were to assess the current state of knowledge about exposure to RD and RCS in copper mines, and to provide recommendations for the development of an airborne dust monitoring programme in Zambia.

Methods: A systematic literature review was conducted, using the PRISMA methodology. The following online databases were searched for relevant research articles about RD and RCS in copper mines: Clarivate's Web of Science, Google Scholar, PubMed, Science Direct, EBSCO Host, and Scopus, using keywords and phrases with boolean operators. Articles were eligible for inclusion regardless of the sampling method used to measure airborne RD and/or RCS (personal exposure or area monitoring), were published in the period 1970–2023, and met the quality requirements.

Results: After full-text screening, nine out of 6 710 potential articles remained. We found that area and personal RD and RCS data in copper mines are not widely documented in the open-access online literature. For personal RCS data, exposure exceeded the occupational exposure or other recognised limits in most sites; the highest personal RCS exposures occurred in sections of the mine where ore was crushed and transported. For mines that only conducted area monitoring of RD, the airborne dust concentrations that were potentially available for personal exposure were relatively low, compared to the RD exposure limit of 3 mg/m^3. Overexposure to RCS occurred even though personal exposure to RD complied with applicable limits in most cases.

Conclusion: We found evidence of personal overexposure to RCS in copper mines, globally. Assessment of RD concentrations alone (even when exposure is under control) is not adequate to protect workers against overexposure to RCS. Zambia needs to develop an RCS monitoring programme for the copper mining industry. The programme should be based on established standards such as the European Standardisation Committee (CEN) standard (BS EN 689:2018), or the South African Mining Industry Code of Practice as the socio-economic conditions of miners are similar in Zambia and South Africa.

INTRODUCTION

Occupational exposure in developing countries remains a challenge and workers in different industries are exposed to a variety of occupational health stressors. One of the most widely studied occupational stressors is airborne dust. Numerous studies of exposure to airborne dust have been conducted in occupational environments such as mining, construction, and pottery.[1] Exposure assessment of airborne dust in an occupational setting such as a mine should include respirable crystalline silica (RCS). As one of the most abundant minerals on earth, it is a component of the dust generated by all mining activities, although the percentage of RCS in the dust differs between sites. Excessive exposure to RCS can lead to the development of adverse health effects, such as silicosis and other occupational lung diseases (OLDs).[2]

Exposure to respirable dust also poses a risk to workers. Dust particulates in the respirable fraction can be deposited deep into the alveoli region of the lungs, which may lead to more severe adverse health effects than those associated with dust deposition in the upper regions of the respiratory tract.[3] The respirable fraction refers to the particulate mass fraction of inhaled particles that penetrate the unciliated airways of the respiratory tract.[4]

Silicosis is a progressive, irreversible fibrotic lung disease. Although the Global Burden of Disease study identified 23 695 incident cases of silicosis in 2017, this is an underestimate because of deficiencies in reporting programmes and limited attention, in many countries, given to sectors other than mining.[5] Several studies have investigated silicosis in copper mines and reported a correlation between exposure to RCS and the development of silicosis and other OLDs.[1,6-8]

Several RCS exposure assessment studies have been carried out across different mining commodities such as coal and gold.[9,10] The percentage of RCS in bulk samples differs across commodities[11,12] and has been well described in these mines. However, there is limited published literature describing results from comprehensive RCS exposure assessment studies in copper mines. Fifty-four countries in the world mine copper, with many mining sites among them.[13] With global copper output anticipated to increase by 40% in the next two decades,[14] due to the pace of electrification and the need for clean energy, this may lead to an increased number of workers at risk of overexposure to respirable dust (RD) and RCS.

Zambia, one of the top copper producing countries in the world, has no national monitoring programme or legislated standard for exposure to airborne dust. Each mining company runs its own programme with standards adopted from the country of ownership; most of the copper mines are owned and run by international companies. Currently, there are two commercial copper mines that are state-owned and each has at least two mining sites.

The country intends to double its copper production by 2031 to meet the global demand caused by the world's green energy pathway. A national monitoring programme for occupational exposure to airborne dust is needed, to address the potential health challenges associated with this increase in copper production and the associated increase in the size of the mining workforce.

This systematic review was undertaken to assess the available knowledge on RD and RCS measurements in copper mines, and provide recommendations for the Zambian Government to consider for its development of an airborne dust monitoring programme.

METHODS

Search strategy

A search for relevant literature was conducted, following the 'preferred reporting items for systematic reviews and meta-analyses' (PRISMA) method.[15] The following online search engines were used to search for published peer-reviewed research papers: Clarivate's Web of Science, Google Scholar, PubMed, Science Direct, EBSCO Host, and Scopus.

The following keywords and phrases with boolean operators were used in the search: 'dust exposure', 'respirable crystalline silica', 'respirable dust', 'exposure to silica', and 'dust'. The word 'copper mine' was coupled to all the search strings, using the boolean operator, 'AND'. The period used to search for literature was 1 January 1970 to 30 August 2023.

After the search was conducted and papers were selected, the web-based tool EPPI-Reviewer (beta version) (University College London, England) was used to review the papers. This programme offers coding, screening, and direct import of studies from the databases that are searched.[16] The software was used to screen the titles and abstracts of articles. For full-text review, a Microsoft Office Excel spreadsheet was designed; all pertinent information was recorded.

Duplicate articles were eliminated before the screening process. This was accomplished by setting the similarity index to 90% in the EPPI-Reviewer web tool. Papers with a similarity index ≥ 90% were identified by the software as duplicates and were excluded. The titles, author(s), years of publication, and abstracts of all papers were also manually screened and compared. If the details were similar, then the papers were considered to be duplicates. This manual process was followed because the EPPI-Reviewer tool considers two articles to be different even when they have a difference of a comma in the title.

The following inclusion criteria were applied in the title and abstract screening stage:

- Original research article
- Written in English
- Addresses measurements of RD or RCS using any sampling method
- Study conducted in a copper mine; if a combination of copper and other commodity mines were studied, then the RD and RCS concentrations for the copper mine, specifically, needed to be available

Eligibility for full-text review was based on two additional requirements, viz.:

- Presentation of concentrations of RD and/or RCS (personal or area monitoring data)
- The article must have met the quality requirements

Articles that reported only area measurements of RD and RCS were included, because they indicate the potential of personal exposure even though they cannot legally be used to estimate exposure limits.

Quality assessment

Two authors independently reviewed the articles at all stages (title, abstract, and full-text screening) for inclusion; disagreements were resolved through discussion with a third reviewer. The quality of the articles selected for full-text review was appraised using the 'standard quality assessment criteria for evaluating primary research papers from a variety of fields' tool (QualSyst).[17] This assessment tool is suited for assessing the quality of studies with a broad range of designs. The authors scored the articles on a scale, as follows: > 80% was rated as high quality, 50% to 79% was considered moderate quality, and below 50% as poor quality. A rating of at least moderate qualified the article for inclusion in the final review.[17]

Data extraction

The extracted data (RD and RCS exposure data, area concentrations of RD and RCS, sampling method, monitoring standard, etc.) were uploaded to an Excel sheet. Compliance of personal exposure to RD and RCS with the relevant occupational exposure limits (OELs) and other limits was evaluated. Area RD and RCS concentrations were used to estimate the potential for exposure. The analytical standard used for quantification of RD and RCS in each article was noted.

RESULTS

Description of the papers included in the systematic review

The detailed selection procedure is presented in Figure 1. Based on the search strategy, using the six online databases, 76 articles were initially identified from Web of Science, 2 790 from Google Scholar, 943 from PubMed, 43 from Science Direct, 2 292 from Ebsco Host, and 32 from Scopus.

Following the full-text screening, all articles met the quality requirements; the highest and lowest quality ratings were 95.45% and 54.55%, respectively. Nine articles were included in the systematic review. The numbers of articles excluded at each stage of screening are shown in Figure 1, and the extracted information is summarised in Table 1. The majority of the studies were published in the last 20 years (2004–2023); the oldest was published in 1989.

The majority of the articles included in the review used 0.1 mg/m^3 as the exposure limit for an 8-hr time weighted average (TWA) for personal exposure to RCS. For personal exposure to RD, only one study reported the 8-hr TWA exposure limit, which was set at 3 mg/m^3. Most articles included airborne RD concentrations conducted using area monitoring.

Most of the mines studied were in the United States of America and used an aluminium cyclone as the size-selective sampling head. The studies from China and Zambia used a nylon cyclone. These size-selective sampling heads were used regardless of the sampling method (area or personal monitoring).

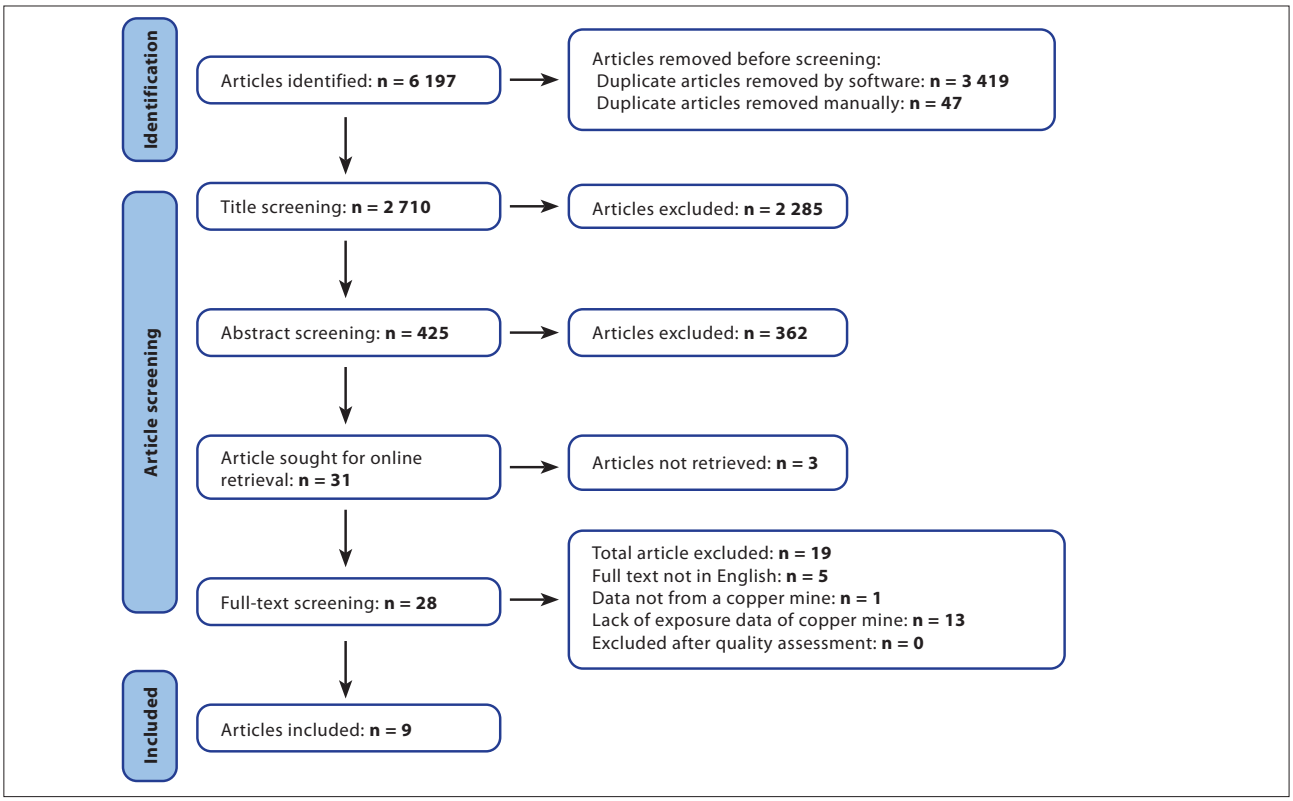

Figure 1. PRISMA flow diagram, illustrating the article selection procedure for the review

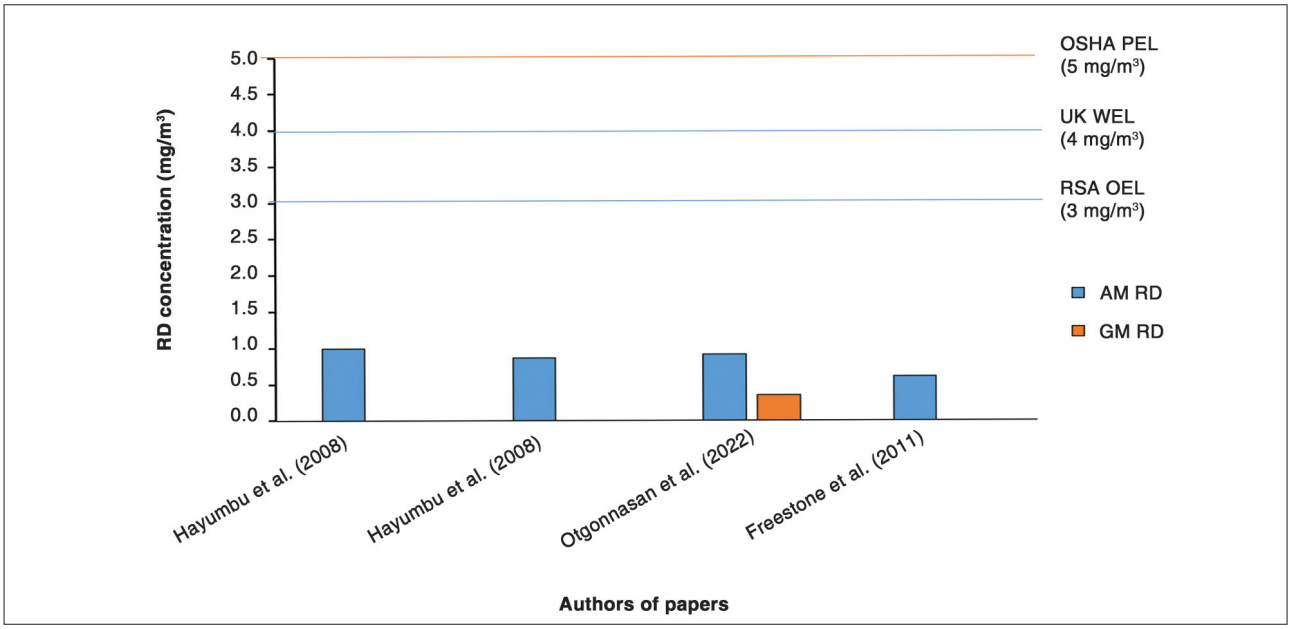

Figure 2. AMs and GMs of personal exposures to respirable dust reported in papers included in the systematic review

AM: arithmetic mean, GM: geometric mean, OEL: occupational exposure limit, OSHA: Occupational Safety and Health Administration, PEL: permissible exposure limit, RD: respirable dust, RSA: Republic of South Africa, UK: United Kingdom, WEL: workplace exposure limit
Hayumbu et al. (2008)[23] and Freestone et al. (2011)[22] did not report the GM for RD.

Table 1. Summarised information from the nine studies included in the systematic review

Author(s)	Country	Aim	Findings	Sampling method/# samples	Type of sampling head	Respirable dust			Respirable crystalline silica dust				
						Range (mg/m³)	AM/GM	EL/% above EL	AM/ GM	Range (mg/m³)	EL used	% above EL	% in sample
Misra et al., 2023[18]	USA	RCS exposures among all M/NM mines	Identified highly exposed groups	Personal/ 639[a]	-	-	-	-	0.070/-	-	0.1 (MSHA PEL)	17.8	10
Otgonnasan et al., 2022[19]	Mongolia	Personal exposure to RD and RCS	Risk of over-exposure to RD and RCS	Personal/ 581[b], 264[a]	Aluminium cyclone	0.020–18.430	0.91/ 0.35	(3 MNS-PEL)/5.9%	0.049/ 0.090	0.001–0.588	0.1 (MNS-PEL)	14.8	-
Cauda et al., 2018[20]	USA	Assess the DoF-FTIR technique for estimation of RCS	DoF-FTIR can be used to estimate RCS	Static	Aluminium cyclone	-	-	-	-	-	-	-	18[c]
Gautam et al., 2016[21]	India	Dispersion behaviour of PM	Equation predicting particle travel time with depth	Static	Particle monitor (Grimm)	0.016–0.197	-	-	-	-	-	-	-
Freestone et al., 2011[22]	USA	Use DRI to predict hazardous metal concentrations	DRI not suitable for measurement of metal concentration	Static/16[b]	Aluminium cyclone	0.146–0.917	0.605/ -	-	-	-	-	-	-
				Static/16[b]	Particle monitor (Haz-Dust)	0.043–0.040	0.203/ -	-	-	-	-	-	-
Zubieta et al., 2009[6]	Mexico	Assess work-related hazards	51% of settled dust was RD	Settled dust	-	-	-	-	-				23% Q in TD
Hayumbu et al., 2008[23d]	Zambia	Characterise RD and RCS exposure	There was over-exposure to RCS	Personal/ 101[a,b]	Nylon cyclone	0.000–7.674	0.99/ -	-	0.143/-	0.000–1.302	0.025 (ACGIH TLV)	78.0	59
				Personal/ 102[a,b]	Nylon cyclone	0.000–6.944	0.868/ -	-	0.060/-	0.000–0.317	0.025 (ACGIH TLV)	53.0	26
Wu et al., 1992[24e]	China	Compare Chinese sampling methods and strat-egies to NIOSH	Bias observed; linear model accounted for 77% of variability	Static	Nylon cyclone	0.460–1.000	-	-	-	-	-	-	10
						0.190–5.100	-	-	-	-	-	-	24
						2.900–5.800	-	-	-	-	-	-	14
						0.130–0.220	-	-	-	-	-	-	11
Romo-Kroger et al., 1989[25]	Chile	Determine Mg, Al, Si, K concentrations	4 out of 5 elements exceeded exposure limit	Personal	Racal helmet	-	-	-	0.189/-	-	0.045	4 times > OEL	-

ACGIH: American Conference of Governmental Industrial Hygienists, AM: arithmetic mean, Al: aluminium, CS: crystalline silica, DoF-FTIR: direct on filter-Fourier-transform infrared spectroscopy, DRI: direct-reading instrument, EL: exposure limit (used in study), GM: geometric mean, K: potassium, M: metal, Mg: magnesium, MNS: Mongolian National Standard, MSHA: Mine Safety and Health Administration, NM: non-metal, OEL: occupational exposure limit, PEL: permissible exposure limit, PM: particulate matter, Q: quartz, RCS: respirable crystalline silica, RD: respirable dust, Si: silicon, TD: total dust, TLV: threshold limit value, USA: United States of America

[a]RCS samples, [b]RD samples, [c]percentage silica in RD, [d]two results from two mining sites, [e]four results from four mining sites

Respirable dust concentrations

Personal exposure to RD across mining sites is shown in Figure 2. All the mining sites did not report AM personal exposure to RD that exceeded the Occupational Safety and Health Administration's (OSHA's) permissible exposure limit (PEL) of 5 mg/m^3, the United Kingdom's Health and Safety Executive's workplace exposure limit (WEL) of 4 mg/m^3, and the Republic of South Africa mining industry's (SAMI's) OEL of 3 mg/m^3.

In all the studies that reported personal exposure to RD, the arithmetic mean (AM) and geometric mean (GM) were below the relevant exposure levels (Figure 2). However, in each mine in which RD was measured, there were incidents of overexposure when considering individual personal exposure values. For example, the AM and GM personal exposures to RD in the paper by Otgonnasan et al. (2022)[19] were 0.91 and 0.35 mg/m^3, respectively, while the highest personal exposure concentration was 18.43 mg/m^3. Hayumbu et al. (2008)[23] also reported maximum personal exposure to RD of 7.674 mg/m^3 and 6.944 mg/m^3 for the two mine sites studied.

In two of the nine articles, sensor instruments were used to measure airborne RD. One of the instruments was the GRIMM Model 1.108 (Durag Group, Hamburg, Germany), which uses the principle of light scattering or extinction to detect and count aerosols, with an algorithm for sizing.[21] It is an area monitoring instrument and supports a filter for further chemical analysis. The other instrument was the Haz-Dust EPAM 5000 (SKC Ltd., Blandford, United Kingdom), which is also used for area monitoring. It has interchangeable sampling heads for PM10, PM2.5 and PM1.0 monitoring. In the study by Freestone et al. (2011),[22] the instrument could not be used to estimate exposure to some metals, while Gautam et al. (2016)[21] successfully used it to estimate the dispersion behaviour of aerosols.

Respirable crystalline silica concentrations

All the five mining sites included in this review reported AMs of RCS exposure concentrations that exceeded the health-based American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV) of 0.025 mg/m^3. The AMs of personal RCS exposure from two mining sites exceeded the European Union (EU) and South Africa OELs of 0.1 mg/m^3, as shown in Figure 3.

To determine the percentage of silica in their samples, Hayumbu et al. (2008)[23] and Wu et al. (1992)[24] used bulk samples; Cauda et al. (2018)[20] and Misra et al. (2023)[18] used RD samples; and Zubieta et al. (2009)[6] used settled dust samples. The articles by Hayumbu et al. (2008)[23] and Wu et al. (1992)[24] appear more than once in Figure 4, because they included more than one mine site in the article describing the study. The percentage of silica reported in the articles included in this systematic review ranged from 10% to 59% (AM = 21.6%). This was calculated regardless of whether the silica content was determined from bulk, personal, or settled dust.

DISCUSSION

Although the copper mining industry has been in operation in Zambia since the 1930s,[23] little has been done, through legislation, to protect workers from overexposure to RD and RCS. The country has no airborne dust-monitoring programme and is yet to set OELs for RD and RCS exposure. This systematic review was undertaken to assess the available RD and RCS measurements in copper mines, reported in published scientific articles, and to provide recommendations for the Zambian Government to consider for its development of an airborne dust-monitoring programme. Data such as airborne dust monitoring standards, airborne dust sampling methods, area airborne RD concentrations, and whether personal exposure to RD and RCS was under control, was noted.

Exposure to respirable dust

For the mines that reported personal exposures to RD, the AMs did not exceed the applicable occupational exposure limit used. However, all three mining sites where personal exposure to RD was measured reported maximum exposures exceeding 5 mg/m^3, which is almost double the SAMI OEL for RD. A worker at the concentrator in the Otgonnasan et al. (2022)[19] study experienced the highest exposure to RD of 18.43 mg/m^3. Thus, all the mines that monitored personal exposure to RD showed evidence of overexposure to RD, as they are all not compliant with the OSHA-PEL, UK-WEL, and RSA-OEL for RD, even though the AM of personal exposure to RD did not exceed the respective exposure limits.

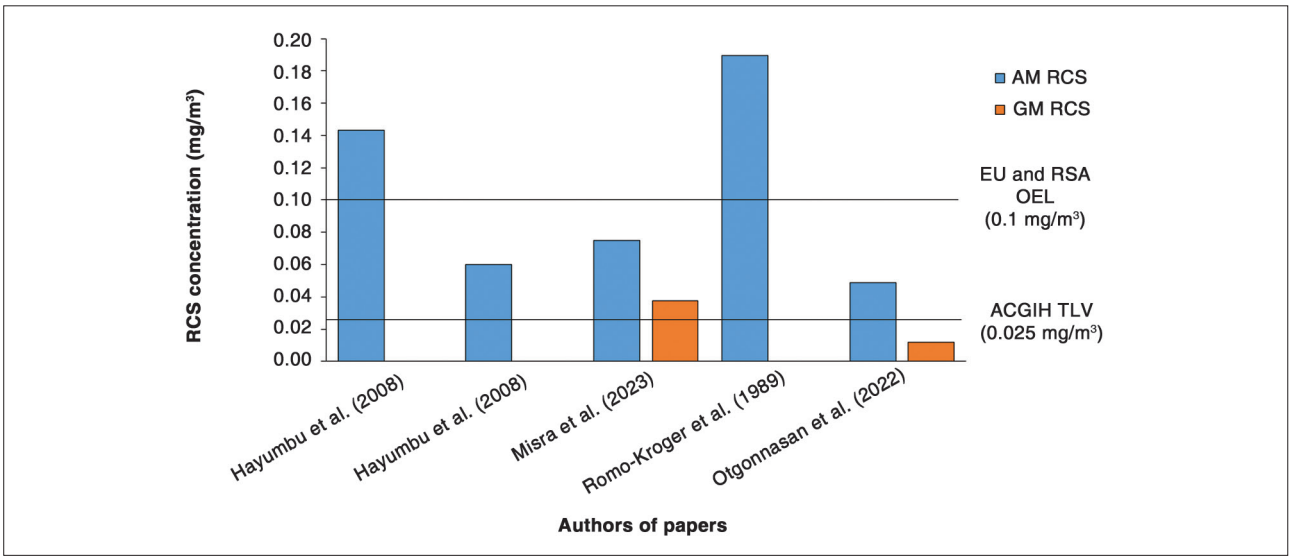

Figure 3. AMs and GMs of personal RCS exposure measurements for copper mines reported in papers included in the systematic review

ACGIH: American Conference of Governmental Industrial Hygienists, AM: arithmetic mean, EU: European Union, GM: geometric mean, OEL: occupational exposure limit, RCS: respirable crystalline silica, RSA: Republic of South Africa, TLV: threshold limit value
Hayumbu et al. (2008)[23] and Romo-Kroger et al. (1989)[25] did not report the GM for RCS.

In one of the nine papers included in this systematic review, an exposure limit of 3 mg/m^3 was used for personal RD exposure compliance testing. If this exposure limit is used for a comparison with area monitoring measurements, then workers in the two mine sites from the four studied by Wu et al. (1992)[24] have potential for overexposure to RD, because the range of airborne RD concentrations for the two mines was 0.19–5.10 mg/m^3 and 2.90–5.80 mg/m^3, respectively. Thus, of the 10 mine sites where RD concentrations were reported, three had evidence of personal overexposure to RD and two had potential for personal overexposure to RD (based on area concentrations).

Since the studies included in this systematic review showed evidence of overexposure to RD in copper mines, Zambia should consider establishing an airborne RD personal exposure monitoring programme. A stringent 8-hr TWA exposure limit of 3 mg/m^3 should be adopted.

Exposure to respirable crystalline silica

Most of the mines reported RCS dust concentrations that exceeded the OELs that they used as guidelines. One measurement above the exposure limit means that exposure is not under control for that section of the mine.[26] Thus, there was a clear indication of overexposure to RCS in copper mines, worldwide. Yet, there are only a few studies that have published reports of personal exposure to RCS in copper mines in open-access scientific journals.

Otgonnasan et al. (2022)[19] established that workers in the sample preparation department were exposed to the highest levels of RCS, and that maintenance workers, operators, drill mechanics, and those working at the crusher had exposure levels exceeding the Mongolian National Standard- (MNS-) PEL. However, in most of the articles included in this systematic review, most of the overexposure RCS measurements were for workers in the concentrator section. Personal exposures reported by Hayumbu et al. (2008)[23] also exceeded applicable exposure limits. The articles included in this systematic review provide evidence for personal overexposure to RCS in copper mines.

The AM (%) of RCS in the mines included in this systematic review was 21.6% (AM) (10–59%), which is comparable to the concentrations reported by Chubb and Cauda (2017) in three gold mines, viz. 21.6% (9–37%).[11] In the four coal mines studied by Keles and Sarver (2022),[12] the percentage of RCS measured from area monitoring was 12.45% (1.45–27.6%). This relatively high percentage of RCS in the airborne RD has implications for RD and RCS monitoring programmes. If, for example, a worker works in an area where the proportion of RCS in the RD is 21.6% and he/she is exposed to an RD concentration of 1 mg/m^3 (30% of the RD OEL of 3 mg/m^3), then he/she would be exposed to 0.216 mg/m^3 RCS (216% the SAMI OEL for RCS of 0.1 mg/m^3). This means that RD sampling programmes will not be able to predict high personal exposure to RCS, which is a challenge to mines that routinely monitor personal exposure to RD only.

Routine personal RD exposure monitoring is not adequate for predicting personal exposure to RCS. Since silicosis is solely due to overexposure to RCS, Zambia should consider a mandatory routine personal RCS monitoring programme in copper mines.

The EU and SAMI 8-hr TWA RCS exposure limit of 0.1 mg/m^3 may not adequately protect miners against the adverse health effects of exposure to RCS. This exposure limit is four times higher than the ACGIH's health-based 8-hr TWA for RCS exposure of 0.025 mg/m^3. In the United States, the 8-hr TWA for RCS was reduced to 0.05 mg/m^3 in 2016.[5] In 2009, Canada also reduced its 8-hr TWA OEL for RCS to 0.025 mg/m^3 for both quartz and cristobalite, from 0.1 mg/m^3 and 0.05 mg/m^3, respectively.[5] South Africa is also considering reducing its 8-hr TWA OEL for RCS from 0.1 to 0.05 mg/m^3.[27]

Zambia should consider the factors that led to these reductions (and considerations for reduction) and socio-economic factors in the country when settings its own exposure limits for RD and RCS.

Exposure assessment standards

The most widely adopted analytical methods in the articles included in the systematic review were the National Institute for Occupational Safety and Health (NIOSH) methods (0600, and 7500 or 7602) for quantification of RD and RSC, respectively.[19,23] Although the authors describe the analytical standards used in the studies, the majority of the studies in which RD personal exposure assessments were conducted did not specify the method used for assigning workers to similar exposure groups (SEGs). An SEG can be defined as a group of workers having the same general exposure to an agent, because of similarity and frequency

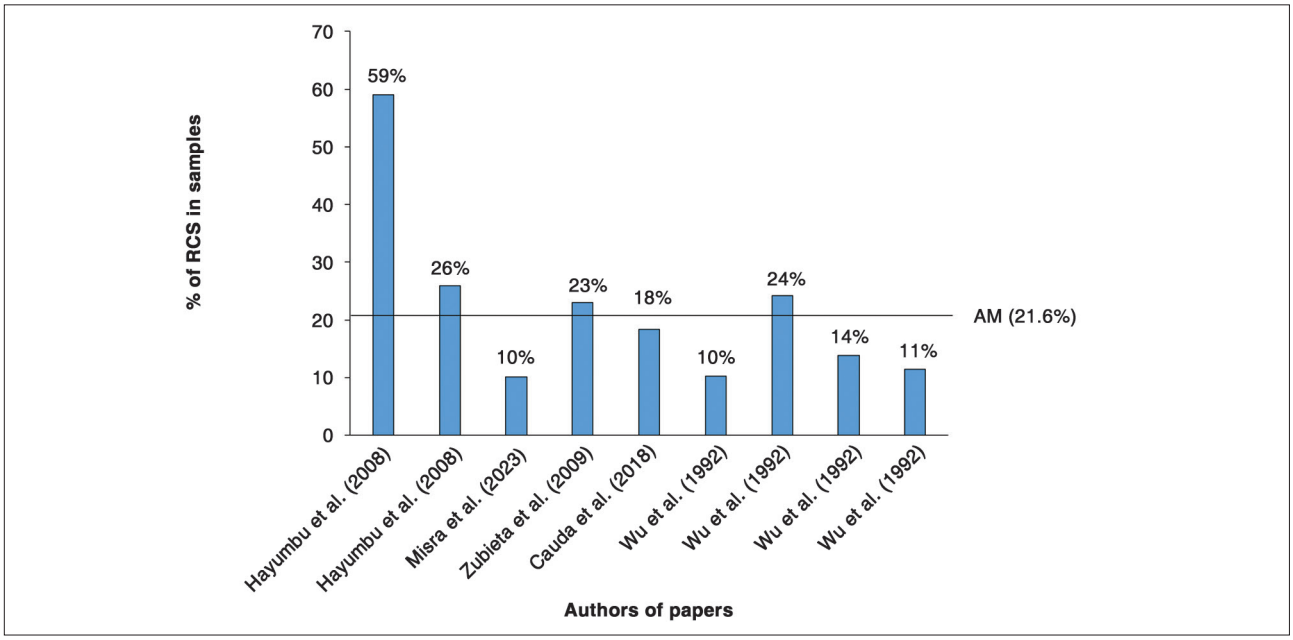

Figure 4. Percentage of silica in dust samples as reported by included studies

AM: arithmetic mean, RCS: respirable crystalline silica

of the task(s) they perform, and similarity in processes and materials with which they work.[26] In some studies, the whole mine was treated as a single SEG. The SEGs represent small sub-populations within the workforce: 5% of workers, with a minimum of five workers, can be selected randomly from each SEG for personal sampling; the results will apply to the whole SEG.[28] This reduces variability of the results and the number of samples that need to be collected, and subsequently reduces the cost of the monitoring programme.

Zambia should also adopt the NIOSH methods 0600 for RD, and 7500 or 7602 for RCS quantifications, as they are widely used. The European Standardisation Committee (CEN) (BS EN 689:2018) standards can also be adopted for assigning workers to SEGs and for compliance testing. The CEN standard is more widely used than the South African Mining Industry Code of Practice (SAMI-COP). This will lead to harmonisation and consistency in exposure data interpretation across copper mines in the different countries.

Real-time monitoring

Instruments containing particle sensors were used in some studies to measure airborne dust concentrations. The main limitation with these instruments is the lack of documented literature on devices that measure the chemical composition of airborne dust. Even when used for RD monitoring, they need to be calibrated, as the material used in the factory calibration may have a different refractive index than the dust at the site, which reduces the accuracy of the instrument. The measured photometric-equivalent mass concentration is highly dependent on the refractive index of the material.[29] However, when calibrated on site, the sensors are invaluable as they provide exposure data in real- or near real-time that can be used for monitoring the efficacy of dust engineering controls.

Zambia should consider legislating the use of real-time airborne dust monitors for the purpose of evaluating the efficacy of dust controls. Respirable dust concentrations take days or more to be analysed by laboratories, while RD concentrations from real-time monitors are available much sooner (in real- or near real-time).

Health risks

Copper mines are not free of cases of silicosis. Several studies have documented the correlation of RCS exposure with the development of silicosis and other OLDs in copper mines. For example, in a study in China, Wang et al. (2020)[1] estimated the incidence of silicosis among copper mine workers as 2.5 per 1 000 person-years. In another study, international health and safety professionals investigated the conditions at an open-pit copper mine in Cananea, Mexico in 2007 and found that workers had the following symptoms: shortness of breath, wheezing, cough, and elevated sputum production.[6] They concluded that these symptoms might be related to dust exposure. A study in Chile monitored 5 939 workers exposed to silica dust and reported an incidence of silicosis of 2.85 per 1 000 miners.[30] This was lower than the incidence rate reported in the Democratic Republic of the Congo, viz. 10.8 per 1 000 miners in the period 1970 to 1995 at Lubumbashi Copper Mine.[8] In Zambia, for the years 2022 and 2023, 66 cases of pneumoconiosis were diagnosed in miners and ex-miners.[31] These studies clearly show that silicosis in copper mineworkers is a global challenge.

Additional recommendations for a dust monitoring programme for Zambia

This systematic review was motivated by Zambia's initiative to develop an occupational hygiene monitoring programme, initially centred on occupational exposure to airborne contaminants in copper mines. Zambia should base such a programme on best-practice sampling methods and technology. Zambia has not established OELs for RD and RCS.[23,31] We recommend that OELs be adopted from countries in Africa with similar socio-economic statuses, until such time as a country-specific OEL is agreed upon. Zambia should consider adopting an 8-hr TWA exposure limit of 0.05 mg/m^3, as countries with well-established exposure monitoring programmes such as the United States and Australia have legislated this limit, while South Africa is considering reducing to this limit. A more stringent exposure limit for RCS might need to be considered when socio-economic factors are taken into account.

There is a shortage of occupational hygienists in Zambia. Competent personnel should be trained and certified to increase the country's capacity to accurately measure RD and RCS exposure concentration, conduct risk assessments, and drive the implementation of control measures.

Limitations

Only articles published in English were included in the review. Those that reported RD and RCS exposure data from copper mines together with other commodities were not included. Both these criteria affected the number of articles included in the systematic review. The average percentage of RCS measured in the mines in the reviewed articles was calculated regardless of whether RCS content was measured from bulk, personal, or settled dust. Thus, the single value of the percentage of silica obtained in each study was an estimate of the RCS concentration that could potentially be in the breathing zone of a mineworker.

CONCLUSION

There is evidence in the literature of overexposure to RD and RCS in copper mines, globally. Zambia needs to develop an airborne dust and RCS monitoring programme for the copper mines, based on established standards and methods used in other countries. Occupational hygienists should be recruited and/or trained to help establish the programme and to implement and monitor it. In the interim, Zambia should consider adopting the NIOSH analytical methods for RD and RCS quantification; established standards such as the CEN standard (BS EN 689:2018) for assigning workers to SEGs and compliance testing; and 8-hr TWA exposure limits of 3 mg/m^3 and 0.05 mg/m^3 for RD and RCS, respectively.

KEY MESSAGES

1. There were relatively few studies in the open-access online literature that documented dust concentrations in copper mines.
2. Most studies on occupational exposure to airborne dust in copper mines have measured measured RD and not RCS.
3. Exposure to RD was better controlled than exposure to RCS in the studies included in the systematic review.
4. Most of the studies used NIOSH methods; 0600 for RD quantification, and 7500 or 7602 for RCS quantification.
5. All papers reported AMs of RCS personal exposure measurements that exceeded the ACGIH-TLV of 0.025 mg/m^3.

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DECLARATION

The authors declare that this is their own work; all the sources used in this paper have been duly acknowledged. The authors declare that no conflicts of interest exist.

AUTHOR CONTRIBUTIONS

Conception and design of the study: LN, MS, DM, PH, MDM, SJLL
Data acquisition: LN, PH, MDM, SJLL
Interpretation of the data: LN, MS, PH, MDM, SJLL
Data analysis: LN, MS, DM, PH, MDM, SJLL
Drafting of the paper: LN, PH, MDM, SJLL
Critical revision of the paper: LN, MS, DM, PH, MDM, SJLL

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AUDA-NEPAD Implementation Completion Report

Southern Africa Tuberculosis and Health Systems Support project, 2017–2024

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Report reference
Southern Africa Tuberculosis and Health Systems Support Project, 2017–2024. AUDA-NEPAD Implementation Completion Report: abridged report; 12 May 2024

SUMMARY

The Southern Africa Tuberculosis and Health Systems Support (SATBHSS) project, initiated in 2016, addressed significant challenges in tuberculosis (TB) control and occupational lung diseases in southern Africa, where mining and other industries led to high exposure risks. Miners were seven times more likely to contract TB than the general population, exacerbating the spread of drug-resistant strains. The project, implemented across Lesotho, Malawi, Mozambique, and Zambia, with regional leadership from the African Union Development Agency-New Partnership for Africa's Development (AUDA-NEPAD) and the East, Central and Southern Africa-Health Community (ECSA-HC), focused on improving TB control, and occupational health and safety (OHS) services.

Key challenges included gaps in occupational health systems, inadequate mine-health regulatory capacity, and limited involvement of private mining companies in disease control. The project supported OHS legislation reviews, human capacity development, and the establishment of centres of excellence (CoEs), such as the OHS CoE in Zambia. Innovations and operational research provided valuable insights and built a foundation for future interventions.

Over seven years, the SATBHSS project achieved significant progress in strengthening TB and occupational disease management, enhancing regional and cross-border disease outbreak preparedness, and promoting a multi-disease approach to health. The project emphasised the importance of sustaining its gains through continuous mentorship, updating OHS legislation, and ensuring ongoing support from the African Union (AU), AUDA-NEPAD, AU member states, and development partners.

SITUATION DURING APPRAISAL

The Southern African Development Community (SADC) region's main economy is based on agriculture, mining, transport, and construction, which are associated with occupational hazards

Mining-related exposures are associated with an increase in the burden of occupational diseases and accidents in the region. Tuberculosis and occupational lung diseases (OLDs) were among the highest burdens in five countries in southern Africa, due to mobility of workers, especially miners, who were seven times more likely to contract TB than the general population. This has also contributed to the spread of drug-resistant TB strains in the population.

Most SADC countries have not rectified International Labour Organization (ILO) instruments on Occupational Health and Safety

The ILO provides key guidance on occupational safety and health (OSH) through Conventions 155, 161, and 187. However, most SADC countries have not ratified these conventions, resulting in a lack of comprehensive OSH policy frameworks in the region.

Limited availability of occupational health and safety services in the region

The main challenges in OHS include limited access to OHS services, inadequate or non-existent national legislation, and the absence of OHS policies. The growing informal economy, particularly in small and informal mining operations, creates various occupational hazards, including exposures to heavy metals and silica-containing dust, and physical hazards in the workplace.

The Declaration on TB in the Mining Sector was signed during the SADC heads of state meeting in Mozambique in 2012

The Declaration outlined key challenges related to occupational health in southern Africa, particularly within the mining sector, where job migration contributed to the spread of infections. Issues faced by miners, ex-miners, and their communities included the lack of cross-border medical referral systems, inadequate legal protection for mineworkers, and lack of surveillance, post-employment follow up, and compensation for OLDs. Occupational health and safety challenges included gaps in occupational health systems and services, inadequate mine-health regulatory capacity in most countries, and limited involvement of private mining companies in efforts to control TB and other diseases. The SATBHSS project was developed to address these issues, specifically in Lesotho, Malawi, Mozambique, and Zambia. In 2020, the project was restructured and refinanced to incorporate COVID-19 pandemic response efforts.

PROJECT DEVELOPMENT OBJECTIVES

The project development objectives (PDOs) were (i) to improve coverage and quality of TB control and OLD services in specific areas in the participating countries, (ii) to strengthen regional capacity to manage

Photograph: courtesy of the AUDA-NEPAD

TB and occupational diseases, and (iii) to strengthen country-level and cross-border preparedness and response to disease outbreaks. The PDOs were technically sound and relevant, and evolved based on early implementation learnings. It was envisioned that five communities of practice (CoPs) would be established for cross-country knowledge sharing in TB care, laboratory and surveillance, research and evaluation, occupational health and safety, and project components.

Relevance of the project development objectives

The ongoing concern for World Health Organization reports is undiagnosed and untreated TB cases (missing TB cases) as the source of spreading TB infection

The project prioritised districts in the four countries based on high disease burdens, border towns, hard-to-reach areas, and high-risk populations (such as miners and ex-miners). The project focused on both demand and supply interventions to enhance early case detection, integrating OHS into public health systems, through capacity building of OHS practitioners in early detection of OLDs and TB. Countries improved mine inspections to meet international standards. However, the direct impact of OHS activities on case detection and treatment success rates could not be validated.

The project was aligned to national and regional sector harmonised and standardised frameworks, strategies and guidelines of the participating countries on TB, health systems strengthening, and occupational health standards

The project helped countries to update occupational health services guidelines, develop standard operating procedures (SOPs), and establish codes of practice for occupational health services, which improved medical surveillance in the mining sector. It also built human resource capacity in occupational health. The regional entities (the AUDA-NEPAD and ECSA-HC) were instrumental in the development of guiding documents to advance the OHS agenda.

The project adapted to the changing environment during implementation

The project remained relevant in the face of the global Pandemic and natural disasters. In partnership with other regional stakeholders, the AUDA-NEPAD developed COVID-19/OHS guidelines, which were adopted by countries in various sectors, including mining, education, health, and service industries.

The project was highly relevant and supported regional collaboration of the components, by working closely with the national ministries of health, mining, and labour

The AUDA-NEPAD provided technical assistance in the review of OHS regulations and mine inspections, and supported the development of country-led CoPs and CoEs. Mentorship was instrumental in enhancing dialogues, knowledge exchange, and sharing of technical expertise.

Success of the project development objectives

Occupational health communities of practice and mine safety standards adopted by countries

Interviews and field visits across the countries and with external stakeholders showed significant achievements. The AUDA-NEPAD focused on strengthening OHS, which led to the development of a CoP for managing OLDs, an inspection compliance tool, and SOPs for occupational hygiene laboratories. These tools enhanced the quality of government mine inspections and improved compliance within the mining industry.

Occupational health and safety practitioners trained

The AUDA-NEPAD supported numerous short-term training opportunities to upskill OHS practitioners in improving the quality and coverage of TB and OLDs in the mining sector. A total of 2 869 OHS inspectors, occupational hygienists, medical doctors, radiologists, and nurses were trained. Training covered the measurement of hazardous chemical substances, occupational noise, the use of portable or tabletop Fourier-transform infrared spectroscopy (FTIR) silica analysis machines and the Nanozen, occupational health principles, ILO Classification of Radiographs of Pneumoconioses, and OHS/COVID-19.

Occupational health and safety policies, legislations, standards, and guidelines updated or drafted

The review of the legislation was preceded by a regional study, viz. 'The state of mine health regulation and occupational health and safety services'. A finding was that the project countries do not have

up-to-date occupational exposure limits (OELs). The technical guidance was provided to assist the countries in reviewing/developing legislation to address issues of OHS and capacity building. Thirty-one legislations/regulations were reviewed; eight were adopted. However, the legal OHS environment remains weak as most of the legislation has not been finalised. This may adversely affect the utilisation of skills, hinder access to services, and reduce compliance.

Occupational health and safety and compensation regulations strengthened

The AUDA-NEPAD planned to facilitate OHS and compensation regulations convened at the Southern Africa Inter-Governmental TB and Silicosis Compensation Engagement – a collaboration with the Tshiamiso Trust and the Medical Bureau for Occupational Diseases (MBOD) in South Africa. The outcomes were the Occupational Health Services Blueprint, and the appointment of an SADC compensation champion. The Tshiamiso Trust agreed to use the existing Occupational Health Service Centre (OHSC) to conduct benefit medical examinations (BMEs) for ex-mine-workers.

Private sector engagement in TB response

The AUDA-NEPAD conducted a study on private sector engagement in TB control in 2019. Private sector engagement varied by country. Malawi focused on for-profit private healthcare providers, non-profit private healthcare, and Christian Health Association of Malawi and Islamic faith clinics. In Mozambique, the aim of private sector engagement was to improve compliance with regulations through the national Drug Regulatory Authority. Lesotho had two models, viz. purchase of health services, and a memorandum of understanding (MoU) with private for-profit providers, through which the Ministry of Health provided free TB medication. In Zambia, the model was based on the inclusion of for-profit healthcare providers, pharmacies, and traditional healers, through service-level agreements with private for-profit health facilities.

Communities of practice on occupational health and safety

Mine Health Regulation CoPs were established to promote joint learning, training, and knowledge dissemination on mine-health regulations. The CoPs engaged government officials and agencies such as the World Health Organization (WHO), TB Union, SADC, and International Organization for Migration (IOM).

Centre of Excellence in Occupational Health and Safety (CoE-OHS)

The CoEs were innovative, catalytic, and satisfactorily undertaken despite delays in infrastructure development. The Occupational Health and Safety Institute (OHSI) renovations and equipment procurement were delayed until the last year of implementation, due to bureaucracies in procurements. The SATBHSS project, through its CoEs, has demonstrated impactful OHS models that provide value for money, effectively leveraging donor and government investments. The next step is to scale these models within and beyond the countries, through strategic partnerships. The CoEs provided a unique and powerful platform for testing innovative solutions to address challenges related to TB and OLDs in the region.

Research studies and advocacy

Research conducted through the SATBHSS, led by the AUDA-NEPAD, was successful at both regional and country levels; findings were disseminated via knowledge-sharing forums. Twenty-eight papers and reports have been published in international peer-reviewed journals, with more than 20 citations. An additional nine manuscripts are under review. The AUDA-NEPAD provided technical assistance and mentorship to countries in their research agenda. Research findings will be more widely disseminated, to be used for advocacy in TB and OHS programming.

EFFICIENCY

The economic analysis conducted during the project's appraisal, in 2016, identified the focus on OLDs and mining communities as a highly cost-effective strategy. By addressing the factors driving TB infections in mines and labour-sending areas, the project aimed to support economic growth through increased export earnings and transfer payments.

AUDA-NEPAD efficiency

A 2019 client satisfaction survey, conducted during the mid-term review, found the AUDA-NEPAD's country support to be effective, particularly in mine-health regulation and occupational health capacity building. However, improvements were needed in conducting regional training and workshops, and implementation support visits.

Factors that affected implementation and outcomes

Simple design for a complex regional project

The project was well structured, with clearly defined objectives and scalable components. The roles and responsibilities of the implementing partners were understood at both regional and national levels.

Readiness for implementation

While the project was well designed and scalable, the time needed for initial preparations, such as resource development, baseline studies, and their role in guiding project activities, was underestimated. Additionally, the readiness of participating countries varied.

Gaps in the results framework

Gaps remained in the detection and care, treatment and compensation of OLDs, throughout the project.

Human resources and organisational capacity

Although the project was implemented satisfactorily, restructuring at AUDA-NEPAD was an issue for both the organisation and the project countries, affecting organisational capacities and implementation progress.

Legislation and regulations

The OHS implementation faces challenges such as the slow revision and development of OHS laws, and the underutilisation of sampling equipment, which reduces the project's ability to contribute effectively to the PDOs.

Technical assistance and capacity building on occupational health and safety

Technical assistance from regional agencies (the AUDA-NEPAD, ECSA-HC, ILO and WHO) and the World Bank was significant in addressing OHS, TB, and OLD at national levels.

Advocacy and knowledge sharing

The CoP and advocacy events that targeted forums at continental, regional, and national levels, including heads of state, ministers, and technocrats, generated momentum for countries to review their policies and legislation with support from policymakers. Evidence shared in these forums also benefited non-project countries such as Eswatini, which has incorporated OHS into its national health strategy.

AUDA-NEPAD PERFORMANCE

The AUDA-NEPAD project team comprised four technical officers with experience in OHS advocacy and project management. The countries reported that human resources were inadequate to support the implementation of action points agreed upon during CoP-OHS meetings. This affected the availability and implementation of AUDA-NEPAD technical skills, and consultants were employed to address the gap.

Best practices

Centre of Excellence on Occupational Health and Safety, Zambia

The CoEs were innovative and catalytic, and their work was successfully carried out despite delays in infrastructure development. The innovative CoE model has demonstrated a cost-effective approach to OHS and public health, leveraging donor and government investments while serving as a valuable regional public health asset. The next step is to up-scale it within and beyond Zambia, through strategic partnerships. Going forward, the CoEs need comprehensive support in health system strengthening, to fully capitalise on the benefits of infrastructure, staffing, and equipment maintenance.

Joint occupational health and safety inspections

Integrating joint OHS inspection structures into existing national frameworks led to early success, by promoting smooth collaboration, effective planning, and resource efficiency. The project also helped countries understand the interconnected roles of the national ministries of health, labour, and mines in advancing OHS.

SUSTAINABILITY

Sustainability is key to healthcare development programmes, ensuring that benefits extend beyond individual project funding. The SATBHSS project incorporated several sustainability elements, including user training, equipment procurement, and robust maintenance service packages to extend the lifespan of equipment. However, a financial sustainability analysis at the appraisal stage revealed that TB and OHS programmes were given low priority in domestic resource allocation.

To boost sustainability at a regional level, the AUDA-NEPAD has established a Human Capital and Institutional Development (HCID) Directorate, where the Human Capital Division houses OHS issues after the finalisation of the project. The Directorate has two staff members seconded to the SADC, and has established a multisectoral and multidisciplinary TB/silicosis/OLD SADC governance structure, supporting regional efforts to end TB and other OLDs.

For effective sustainability of the CoE-OHS, a hybrid funding model is required to allow resource mobilisation from domestic and external sources. It should also strengthen research and consultancy services – both in-country and regionally – and advocate for a ring-fenced budget for the CoE-OHS from the Government of Zambia.

LESSONS AND RECOMMENDATIONS FOR REGIONAL AND COUNTRY LEVELS

The lessons and recommendations from the seven-year implementation of the SATBHSS project are instrumental to ensure that learnings are applied in future regional health projects.

The AUDA-NEPAD regional staff complement supported the countries in the targeted implementation of occupational health and safety interventions, where technical expertise was lacking

The AUDA-NEPAD staff complement needs to be bolstered for future regional operations (beyond external experts), based on evolving technical needs to boost OHS interventions.

Occupational health and safety regional support provided critical infrastructure and equipment and capacity building, which was useful for the SATBHSS project and led to the establishment of occupational health and safety clinics, targeted at mining populations

We recommend adoption and finalisation of the remaining OHS country legislations and policies to accelerate institutionalisation and financing of OHS interventions, within the national ministries of health, labour, and mining.

The AUDA-NEPAD propelled the advocacy agenda on TB and occupational health and safety at country and continental levels; however, we note the decreasing domestic financing in TB and occupational lung diseases

Future projects should have targeted advocacy and innovative message-delivery platforms, including community ambassadors at the regional level. The AU platform should be utilised and outcomes of advocacy efforts should be tracked and assessed. For example, the United Nations High Level Meeting on TB has been instrumental to setting and monitoring global TB targets. The SADC Declaration on TB in the Mining Sector, in 2012, should also be monitored to assess country progress.

Sustainability

Implementation, using country government structures and enhancing capacity, is critical for ensuring that the SATBHSS project interventions are sustained beyond the life of the project.

Maximise partnerships at regional level

The partnership between the AUDA-NEPAD, ECSA-HC, and World Bank, as well as the Regional Advisory Committee and CoPs, provided supportive regional mechanisms for the SATBHSS project. This ensured complementary financing and reduced duplications of efforts and transaction costs, with economies of scale in the provision of technical assistance. The partnership was supported by joint implementation support missions led by the World Bank, ensuring comprehensive follow up and supervision of project activities.

Engagement with external consultants and non-governmental organistions

When working with external consultants, non-governmental organisations (NGOs), or multiple implementing entities, it is critical to ensure effectiveness and uniformity in the delivery of interventions so that agreed-upon service delivery is of acceptable quality. This requires close monitoring and supervision. We noted

a good practice in Mozambique, where the IOM supported the implementation of the OHS clinics with a good success rate, despite the slow transition and future sustainability not being assured.

The regional coordination role should be facilitative and not overburdened by protocols and procedures

Despite facing challenges in bureaucracy and implementation, the AUDA-NEPAD demonstrated agility by focusing on core technical areas in OHS and creating effective knowledge-sharing platforms. It also built strong partnerships with the ILO Brazil, MBOD, SADC, and AU.

The multisectoral approach to occupational health and safety service delivery at regional and national levels was game changing in resources sharing and coordination

Combined with regional guiding documents, this approach enables the replication of service delivery across countries, with the use of standardised OHS tools and SOPs. We recommend that the AU, AUDA-NEPAD, AU members states, development partners, and the donor community sustain the project gains, focusing on legislative and regulatory frameworks.

The community of practice created a forum for collaboration and information sharing between regional stakeholders, academia, industry, and regulatory institutions to share lessons and best practices on occupational health and safety issues

Regional conferences and knowledge-exchange forums should continue as tools for stakeholder education and capacity improvement, sustaining buy-in to the OHS improvement agenda. This should extend beyond the mining and minerals industries; national policies and tools should be inclusive of all sectors in which OHS is needed.

Information management to track occupational health and safety and inform decisions on continuous improvement is a critical tool to support countries in measuring their progress in occupational lung disease and TB outcomes

Countries do not currently have indicators to track OHS outcomes. The project supported the development of an OHS information system, but this is yet to be fully rolled out. Integration into national information systems would have been useful.

Southern Africa Tuberculosis and Health Systems Support Project Implementation Completion and Results Report for Zambia, 2017–2023

INTRODUCTION

Project context and development objectives

Global context

The Southern Africa Tuberculosis and Health Systems Support (SATBHSS) project was launched in 2016. Although tuberculosis (TB) is preventable and curable, it is one of the leading infectious causes of death, globally, surpassing human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS). Despite the Millennium Development Goals' success in reducing TB incidence, there were still 9.6 million new cases and 1.5 million deaths from TB in 2014[1]; 99% of cases were in low-income countries[2]. A 2015 survey conducted by *Médecins Sans Frontières* and the Stop TB Partnership in 24 countries, including Zambia, revealed significant disparities between current TB control policies and the essential best practices needed to achieve the global target of a 90% reduction in TB incidence, and a 95% reduction in TB mortality, by 2035. The results of the survey showed that many countries needed to update their policies in line with international standards. There was a need to use rapid molecular tests for the diagnosis of TB and to reduce expenses for people with TB. This, coupled with innovative approaches to active case finding, would help reach the nearly four million TB cases missed each year.

Regional context

In 2014, sub-Saharan Africa had the highest rates of TB and the poorest treatment outcomes, globally. With an estimated incidence of 281 cases per 100 000 population, sub-Saharan Africa's TB incidence surpassed the global average of 133. The rise in TB cases in southern Africa was largely propelled by the HIV epidemic, and the mining industry had historically been associated with some of the highest TB incidence rates. In 2012, the Southern African Development Community (SADC) Heads of States recognised mining activities as one of the drivers of TB and other occupational lung diseases (OLDs) in the region. Consequently, they signed the 2012 Declaration on TB in the Mining Sector, which advocates for a supportive policy environment to address and control TB, HIV, silicosis, and other OLDs. The Heads of States committed to providing appropriate legislative and regulatory authorities and public health resources to eradicate TB. A code of conduct, endorsed by the Health Ministers of the SADC, was integral to this commitment.

The SADC had adopted the Minimum Standards for the Prevention, Treatment and Management of TB to guide a regional approach to controlling the TB burden, which proved instrumental in the implementation of the SATBHSS project. The African Union also adopted the 2015 Catalytic Framework to End HIV/AIDS, TB, and Malaria by 2030 (the World Health Organization (WHO) End TB Strategy) as a framework to guide the TB response in Africa. This was also critical in guiding the project implementation and providing strategic focus, and proved essential during the mid-term review of the project.

Zambian context

Despite significant progress through implementation of the WHO 'TB DOTS' and 'STOP TB' strategies prior to the inception of the SATBHSS project, Zambia remained one of 30 countries in the world with the highest TB burdens. HIV prevalence among TB-diagnosed patients in Zambia varied between 50% and 70%, but the burden of TB/HIV co-infections in miners was not known at the time of appraisal.

The 2013/2014 TB survey revealed that the adult prevalence of bacteriologically confirmed TB in Zambia was 638/100 000, and that the estimated prevalence of all forms of TB was 455/100 000 for all age groups. Ninety-seven percent (258 of 265) of TB cases diagnosed were not on treatment at the time of interview[3]. Up to 50% of patients with symptoms suggestive of TB, who were not on treatment, sought care in health facilities, but the health system failed to identify them.

Lessons learned from previous projects that informed the implementation of the SATBHSS project

The project design was informed by good practices and lessons learned from both regional and country project experiences, such as the Global Fund Tuberculosis in the Mines project, the Great Lakes Emergency Sexual and Gender Based Violence & Women's Health project, the Sahel Women's Empowerment and Demographics project, and public–private collaborations focusing on communicable disease control such as the African Programme for Onchocerciasis Control in West Africa, and the Lubombo Spatial Development Initiative, which focused on malaria control in south-east Africa.

Project development objectives

The project development objectives (PDOs) were developed to:

1. Improve coverage and quality of TB control and occupational lung disease services in targeted geographic areas of the participating countries
2. Strengthen regional capacity to manage the burden of TB and occupational diseases
3. Strengthen country-level and cross-border preparedness and response to disease outbreaks

[1] World Bank; March 2014. https://thedocs.worldbank.org/en/doc/770861483124917730-0010022016/original/AmongSouthernAfricasMineworkersBenefitsandCostsofReducingTuberculosis.pdf
[2] World Bank; May 2018. https://documents1.worldbank.org/curated/en/763241529292640506/pdf/FINAL-20180529-Project-Appraisal-Document-PAD-05292018.pdf
[3] Kapata N, Chanda-Kapata P, Ngosa W, Metitiri M, Klinkenberg E, Kalisvaart N, et al. The prevalence of Tuberculosis in Zambia: Results from the First National TB Prevalence Survey, 2013–2014. PLoS One. 2016; 11(1):e0146392. doi: 10.1371/journal.pone.

Five communities of practice were envisaged, based on consultations between the four participating countries, the World Bank, and regional entities:

1. Continuum of TB care led by Malawi
2. Laboratory and surveillance led by Mozambique
3. Research, monitoring, and evaluation led by Lesotho
4. Occupational health and safety led by Zambia
5. Project components

Components and sub-components to address the project development objectives

Component 1: Innovative prevention, detection, and treatment of TB

This component improved the demand for, and availability of, high-quality TB, TB-HIV/AIDS, and OLD services in targeted geographic areas of the four participating countries. WHO's End TB Strategy, the Harmonised Framework for the Management of TB in the Mining Sector, the SADC Code of Conduct for the Management of TB, and national plans provided a sound framework. Sub-components were 1) enhancing case detection and treatment success, and 2) rolling out a standardised package of occupational health services and mining safety standards across the four countries.

Component 2: Regional capacity for disease surveillance and diagnostics, and management of TB and occupational lung diseases

This component supported strengthening critical areas of health systems to improve efficiency and effectiveness of TB and OLD control, and to improve health system responses to infectious disease outbreaks. During the additional financing phase, the focus was on improved functioning of cross-border committees between participating countries and other neighbouring countries, supporting national responses to the COVID-19 pandemic through improvements in capacity and quality of laboratory and X-ray diagnoses, and capacity building of health staff for COVID-19 pandemic responses, TB management, occupational health, and mine safety and health. Sub-components were 1) improving quality and availability of human resources in the targeted areas, 2) strengthening diagnostic capacity and disease surveillance, 3) strengthening mine health regulations, and 4) supporting COVID-19 responses and integrated TB and OLD care.

Component 3: Regional learning and innovation, and project management

Component 3 funded technical support to strengthen regional capacity and promote innovation through sharing of knowledge and evidence from interventions implemented under Components 1 and 2. It also supported advocacy for policy reforms and for better accountability by mining companies on the enforcement of occupational and mine health standards. Sub-components were 1) operational research and knowledge sharing, 2) centres of excellence in TB and OLD control, 3) regional coordination, policy advocacy, and harmonisation, and 4) project management.

The theory of change on achievement of the project outcomes is summarised in Figure 1.

Implementation structure for the SATBHSS project in Zambia

The SATBHSS project initiative recognised that combating TB required a broad health systems approach, involving various stakeholders in the country and the region. Therefore, a multi-sectoral approach was adopted in Zambia. The Ministry of Health (MoH), Ministry of Finance, Ministry of Labour and Social Security (MLSS), Ministry of Mines and Minerals Development (MMMD), and the Occupational

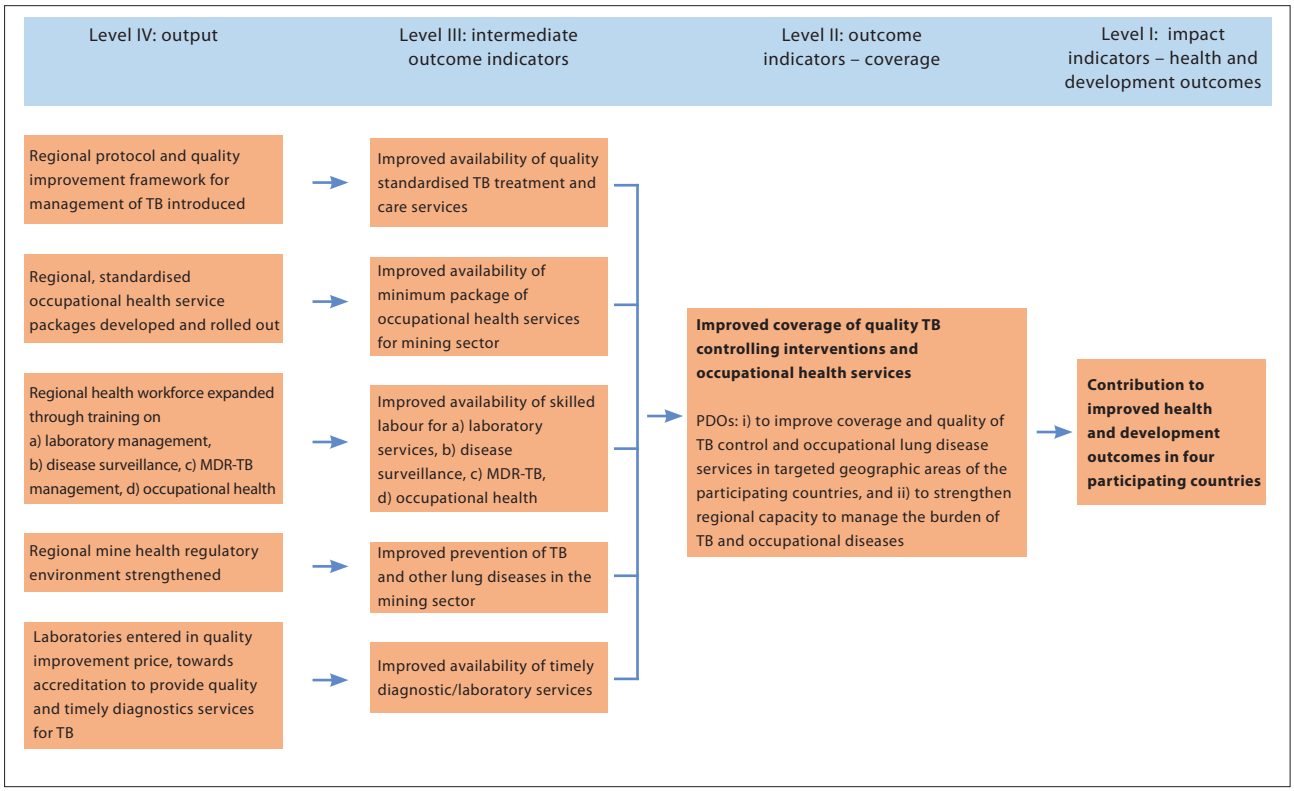

Figure 1. Southern Africa Tuberculosis and Health Systems Support project theory of change

PDO: project development objective, TB: tuberculosis, MDR-TB: multidrug-resistant tuberculosis

Health and Safety Institute (OHSI) were the leading institutions for implementation. The project was designed to work closely with other partners and organisations in the country (the Global Fund, TB in the Mining Sector (TIMS) project, Centers for Disease Control and Prevention (CDC), WHO, Centre for Infectious Disease Research in Zambia (CIDRZ), Zambia Tuberculosis and Leprosy Trust (ZATULET), Chamber of Mines, Tropical Diseases Research Centre (TDRC), University of Zambia School of Public Health, Mine Workers' Union, Ex-miners Association of Zambia, and Eradicate TB under PATH), with the aim of preventing the duplication of activities while enhancing synergism among all stakeholders involved in the fight against TB. Nineteen districts were selected, based on TB prevalence, HIV prevalence, transport corridors, and mining activities.

The East, Central and Southern Africa-Health Community (ECSA-HC) primarily served as the regional coordination organisation, while the AUDA-NEPAD coordinated efforts on policy advocacy, private sector engagement, and occupational health and safety (OHS) aspects of the regional project. Clear delineation of roles was established among the two regional entities, with the Regional Advisory Committee (RAC) providing oversight, leadership, and guidance. All were Government-led, with Permanent Secretaries from each of the ministries of health, labour, and mines in the four participating countries spearheading efforts.

OUTCOMES

Relevance and coherence of the project development objectives

The PDOs were highly relevant. The project was in line with Zambia's 7th National Development Plan upon which all national strategic plans were based, i.e. the MoH's National Strategic Plans 2017–2021 and 2022–2026, and the OHSI strategic plan that envisions a TB- free Zambia by 2030. The project played a significant role in the implementation of these strategic plans.

Training, capacity building, and deployment of specialised equipment and infrastructure development

The project provided technical assistance and capacity-building support to enhance the skills and knowledge of healthcare workers, laboratory staff, and programme managers involved in TB control in Zambia. This included training on TB diagnosis, treatment, surveillance, infection control, and programme management. The project supported the improvement of TB diagnostic and treatment facilities in Zambia by providing funding and technical assistance for the renovation, expansion, and equipping of laboratories, clinics, and healthcare facilities.

Health information systems

The project supported the development and enhancement of health information systems for TB surveillance, monitoring, and reporting, which included the implementation of electronic reporting systems, data quality improvement initiatives, and training on data management and analysis.

Monitoring and evaluation

The project assisted Zambia to strengthen its monitoring and evaluation systems for TB control, including the development of monitoring and evaluation frameworks, indicators, and data-collection tools. The project provided critical support to advance progress toward milestones and targets laid out in the WHO's End TB Strategy and the United Nations Sustainable Development Goals (SDGs).

Zambia is one of seven countries that reached the first milestone of the End TB Strategy – a 20% reduction in TB incidence from the baseline in 2015. The project also contributed to the attainment of the United Nations High-Level Meeting (UNHLM) targets; Zambia has already attained the target for TB case finding.

The project was fully in line with the Regional Integration Assistance Strategy (RIAS), the Africa Strategy, and the Country Partnership Framework (CPF) Strategies. Implementation of Pillar III of the RIAS – Coordinated Interventions to Provide Regional Public Goods – was directly supported by the project, given its aim to strengthen regional capacity to manage the burden of TB and OLDs, with cross-border dimensions. The project contributed to Focus Area II of the CPF, which sought to facilitate inclusive human capital development and strengthen national capacity to respond to disease outbreaks and broader public health emergencies. The project also contributed to the implementation of the International Health Regulations, the Global Health Security Agenda, and International Bank for Reconstruction and Development (IBRD)/International Development Association (IDA) priorities for improving disease preparedness and response.

The project came at a critical juncture in TB control efforts after the endorsement of the SDG target to end TB by 2030. In addition, it directly contributed to meeting the International Health Regulations 2005. At the sub-regional and country levels, the project directly advanced the implementation of the SADC Declaration on TB and the 2008 Maputo Declaration on Health.

Strengthening OHS services in mining areas in Zambia is crucial for the wellbeing of workers, reducing injuries and fatalities, improving productivity and efficiency, ensuring legal compliance and reputation management, safeguarding communities and the environment, and empowering workers and trade unions. It requires collaborative efforts among governments, mining companies, workers' organisations, civil society, and other stakeholders to create a culture of safety, promote responsible mining practices, and achieve sustainable development in the mining sector. The project supported the four Government institutions in Zambia, viz. the Mines Safety Department (MSD), the OHSI, the Workers' Compensation Fund Control Board (WCFCB), and the Occupational Safety and Health Services Department (OSHSD), to become the Centre of Excellence (CoE) for OHS. The CoE offers primary prevention services that include mine inspections, hazard identification, risk assessments, and implementation of an OHS management system across the mining industry. Secondary and tertiary prevention are provided by the OHSI and WCFCB authorities.

The CoE has enhanced the OHS agenda in Zambia by improving quality of, and access to, OHS services. The CoE has aligned the operations of the four institutions linked to the provision of OHS services, namely the OHSI, WCFCB, OSHSD, and MSD.

Multi-sectorial support for TB

The SATBHSS project brought together different sectors of Government and the private sector to work on a common agenda of TB control.

Efficacy of the project

Achievements of the project development objectives (results framework analysis)

The project had a clear results framework, with indicators to measure the achievement of the PDOs. All seven of the project outcome indicators (POIs) and 14 of the 17 intermediate outcome indicators (IOIs) have been either fully or partially achieved.

The project performed well on 1) TB case notification in target geographic areas, 2) TB cases identified through active case finding in target geographic areas, 3) project-supported laboratories compliant with regionally harmonised standard operating procedures (SOPs) for surveillance of multidrug-resistant tuberculosis MDR-TB, and 4) countries with multi-hazard preparedness plans. Reasons for underperformance in some areas included lack of funds to sustain the nutritional support and mining inspections, and unrealistic targets, particularly related to construction.

Monitoring and evaluation data utilisation

Monitoring and evaluation data utilisation is critical in enhancing programme effectiveness, informing decision-making, promoting accountability, and fostering learning and innovation. The monitoring and evaluation data were used to inform project management and decision-making at country and regional levels. Data were reviewed quarterly to assess performance and provide guidance on interventions.

EFFECTIVENESS OF THE PROJECT

This section describes the overall progress of the project against expected results (outcome and coverage performances), and the effectiveness of the project's strategies.

Component 1: Innovative prevention, detection, and treatment of TB

Sub-component 1.1: Enhancing TB case detection and treatment success

This sub-component aimed to increase TB case detection and treatment success rates in line with the National TB Strategic Plan, which, together with interventions such as TB preventive treatment, would decrease TB incidence and mortality rates, ultimately helping Zambia to achieve the goal of eliminating TB by 2030. Although the project focused on 19 districts, all districts in Zambia benefited from the health system strengthening component of the project.

Enhancing TB case detection

The project aimed to detect and treat 175 749 TB patients from 2017 to 2023. By the end of the project, 198 201 patients had been detected and treated, surpassing the target by 13%. In the same period, 311 308 people with TB were diagnosed and received treatment nationwide. This translated to 64% of all national TB notifications being attributed to the project. The proportion of laboratory-confirmed TB patients among those with pulmonary TB fluctuated between 44% and 60%.

The project's investments complemented other support from the Global Fund to fight AIDS, TB, and Malaria. The United States Government contributed significantly to an exponential increase in

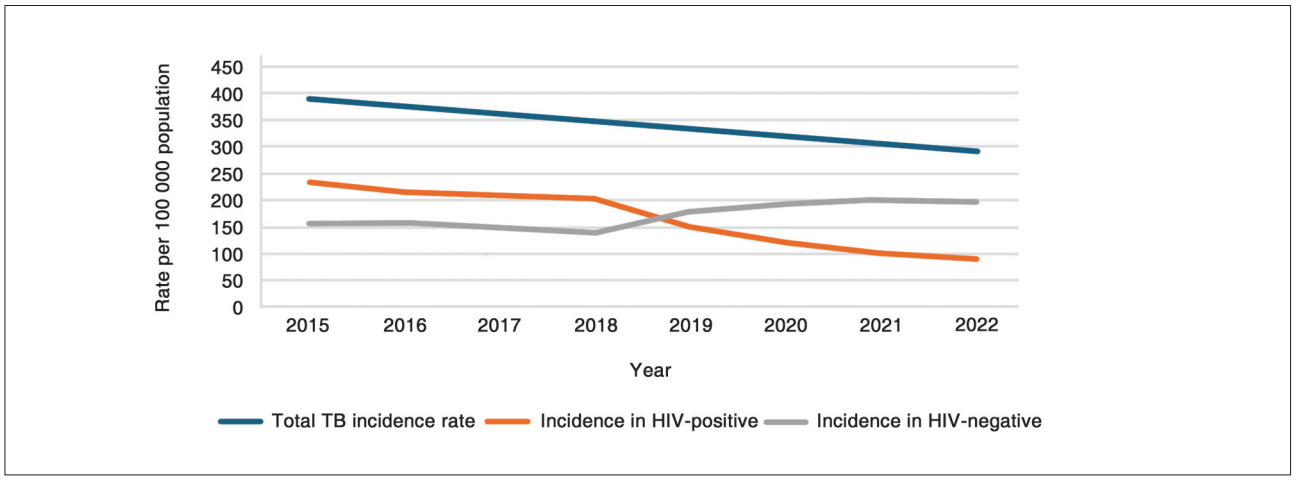

Figure 2. Trends in TB incidence rates (2015–2022)

HIV: human immunodeficiency virus, TB: tuberculosis

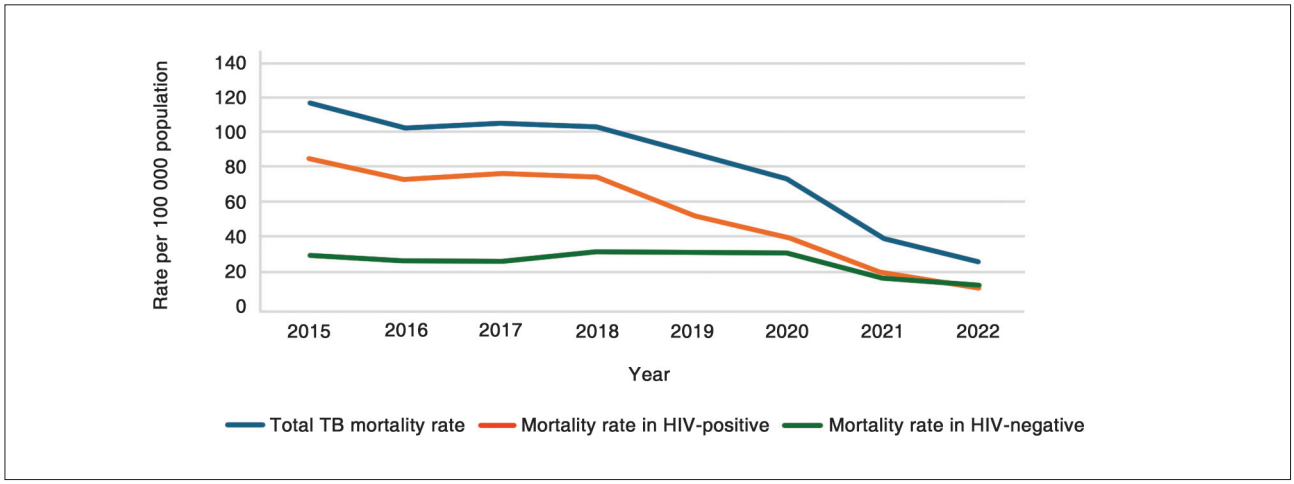

Figure 3. Trends in TB mortality rates (2015–2022)

HIV: human immunodeficiency virus, TB: tuberculosis

TB notification, despite the cholera outbreak in 2018 and the COVID-19 pandemic from 2020 to 2022. This stellar performance was made possible by investing in TB diagnostic tools, reagents and supplies, infrastructure, and innovation in systematically organising TB case-finding approaches in health facilities and the community. For example, in 2018, the project procured 48 GeneXpert machines and, in 2022, four X-ray diffractometer (XDR-TB) machines were procured. In 2020, the country faced a critical shortage of GeneXpert cartridges, which posed a threat to TB case-finding efforts. However, the project's provision of 200 000 GeneXpert cartridges ensured the continuity of TB case-detection efforts.

In 2021, the project took a significant step forward by introducing four new mobile diagnostic units to the health sector. These state-of-the-art units came equipped with digital X-ray and artificial intelligence technology. They allowed the MoH to provide X-ray services to vulnerable populations in rural areas.

Investments from the project were also directed towards implementing active case-finding innovations aimed at detecting TB patients, through an initiative dubbed *"marching towards finding 45 000 and 55 000 TB patients in 2020 and 2021, respectively"*. This innovative approach involved implementing TB case finding in health facilities by ensuring that TB screening was routine and permanent, and conducted at all entry points and units systematically, complemented by community-based active case finding.

Impact attributed to the project investments

The TB incidence rate dropped from 391 cases per 100 000 in 2015 to 295 cases per 100 000 in 2022; a decrease of 26% (Figure 2). This remarkable progress enabled Zambia to achieve the 2020 End TB Strategy milestones. The country has also made significant strides in reducing the TB mortality rate, with the rate falling from 115 deaths per 100 000 population in 2015 to 27 deaths per 100 000 population in 2022; a reduction of 77% (Figure 3). This means that Zambia has already met the 2025 End TB Strategy milestone.

The WHO has recognised Zambia's remarkable achievements in reducing TB incidence and mortality rates. Zambia has been placed among the 83 nations, worldwide, that have recorded a decline in TB incidence of 20% or more from the 2015 baseline. Furthermore, Zambia has been recognised among the 47 countries that have successfully reduced TB mortality by 35% or more. These achievements are a testament to Zambia's commitment to fighting TB and improving the overall health of its citizens.

Sub-component 1.2: Rolling out a standardised package of occupational health services and mining safety standards across participating countries

The project in Zambia provided a comprehensive package of occupational health services through the OHSI, MSD, OSHSD, and health facilities, using a multi-sectoral approach. These institutions are responsible for primary, secondary, and tertiary prevention. Primary prevention services include mine inspections, hazard identification, and risk assessments. Secondary and tertiary prevention are provided by the OHSI and WCFCB authorities. The OHSI provides occupational health surveillance and impairment evaluations for workers. The WCFCB provides compensation for disabilities and diseases.

The main activities that were funded under this sub-component included:

1. Strengthening the capacity of public sector agencies responsible for mine health and safety to undertake inspections of mines, with an emphasis on determining dust levels and control measures, and compliance with mine health regulations
2. Expanding periodic screening and referral for OLDs and other diseases, in line with standards set within the sub-region and international best practices
3. Developing/strengthening care programmes for workers with OLDs

Occupational Health and Safety Institute

The project provided for an improvement of the Institute in terms of infrastructure, viz. massive upgrades of essential diagnostic equipment to replace obsolete technologies, and building capacity of human resources in OHS.

The OHSI was able to increase occupational health services in the project districts, specifically related to medical surveillance examinations of miners and ex-miners, and hazard assessments.

Activities in the project districts were aimed at ex-miners who might not have been able to visit the Occupational Health Service Centre for medical surveillance (specifically for silicosis). Consequently, an additional 1 500 ex-miners were identified, and certification for OLDs increased by 5.4% from 2018 to 2023. Support to the outreach programme included the provision of vehicles and a mobile X-ray truck, and logistics that enabled efficient delivery of the surveillance services.

There was an overall decrease in the number of disease certifications in 2018. There was a gradual decrease in the number of TB cases certified from 2017 to 2021, and a surge in pneumoconiosis cases from 2019 to 2020. Silicosis case notification increased by 283% from 2017 to 2023, and pulmonary tuberculosis (PTB) with silicosis case notification increased by 83% over the same period. Tuberculosis case notification in the mines decreased during the same period by 38%. Collaboration with the district and provincial health offices enabled the provision of TB medications.

Compliance in medical surveillance examinations increased across the mining industry. The number of joint compliance inspections increased, and awareness improved among employers, employees, and the community due to programmes carried out by the OHSI.

Diagnostic capability to detect OLDs in line with international best practice guidelines was improved, through a combination of equipment provision and enhanced competencies of OHSI staff. The provision of, and training in, spirometry, audiometry, and vision-screening equipment enabled the enhancement of medical surveillance and improved health outcomes.

The X-ray department of the OHSI was modernised with digital mobile and fixed X-ray equipment, which improved the quality of the chest X-ray images. This, in turn, reduced waiting times for miners in line for X-rays from two hours to five minutes. The adoption of the International Labour Organization (ILO) International Classification of Radiographs of Pneumoconioses improved the rate of diagnosis and certification of pneumoconiosis and other OLDs. Overall, costs for the OHSI were drastically reduced.

The provision of a GeneXpert machine and other laboratory equipment improved the diagnosis of TB according to the WHO guidelines, and physiology equipment assisted in the diagnosis and assessment of OLDs.

To improve service delivery, information and communication technology (ICT) infrastructure was improved. A new server was installed and secured, and the network improved. To improve skills in reading of chest X-rays, B-reading computers were procured for training in the ILO International Classification of Radiographs of Pneumoconioses. Scanners and computers were procured to

digitalise medical records. This improved ICT infrastructure allowed for the electronic transfer of employee certificates of fitness, further reducing costs.

The results of a client satisfaction survey about service delivery at the OHSI showed that 94% of miners and ex-miners were satisfied with the examination processes, and 97% were satisfied with the state of cleanliness.

Ministry of Labour and Social Security

The mapping of ex-miners was successfully undertaken in six provinces; 14 997 ex-miners were mapped. Only 42.4% of the ex-miners underwent routine medical examinations, mostly at government hospitals; only 5% went to private hospitals. The distributions of ex-miners and health facilities from the districts that were sampled are shown in Figure 4. Most were in the Copperbelt districts.

The MLSS developed the Communication and Advocacy Strategy on Tuberculosis and other Occupational Lung Diseases for Ex-Miners in Zambia: 2019–2023, to increase awareness of TB and other OLDs.

The procurement of occupational hygiene and environmental monitoring equipment enabled the execution of specialised services that were not possible before the SATBHSS project. Equipment included gas analysers, gravimetric dust samplers, sound level meters, a motor vehicle, portable gas detectors, multi-functional gas and dust detectors, heat stress meters, a data-logging personal noise dosimeter, anemometers, personal multi-gas detectors, personal dust sampling kits, and respirator fit testers.

Mines Safety Department

The MSD focused on the following areas: integrated inspections, dust sampling, risk assessments, and audits; stakeholder engagement workshops to promote safe mining; legislative reforms; institutional capacity building; increasing the demand for medical examinations for TB and other OLDs; and mainstreaming OSH in tertiary education curricula.

Three hundred and sixty-five mines were inspected during the project lifetime; 1 499 inspections were conducted and, on average, 94.3% mines were inspected twice or more, annually. A total of 15 305 dust samples were taken, of which 12 656 were compliant (< 1.05 mg/m3). As of 2023, the compliance level for dust was 96.3%.

Component 2: Regional capacity for disease surveillance and diagnostics, and management of TB and occupational lung diseases

Sub-component 2.1: Improving quality and availability of human resources in the target areas

Under this sub-component, the project focused on improving quality and availability of human resources for health in the target areas. The situation analysis on human resources to attend to TB and other lung disease, before the start of the project, indicated that human resources for health were below the WHO-recommended density (no. per population). This shortage hampers disease surveillance, TB control efforts, quality of healthcare, and laboratory testing services. Additionally, poorer rural areas, mining and peri-mining areas, transport corridors, and cross-border areas were particularly affected by these gaps.

The capacity building for human resources aimed at developing a skilled health workforce related to project activities, based on a regionally defined curriculum, mentoring, and knowledge sharing in three critical areas: 1) case detection and management of TB, 2) mine health regulation and occupational services, and 3) disease surveillance. The total investment was US$15.24 million.

The target number was 4 200, but 5 989 staff were trained under the short- and long-term training programmes from 2017 to 2023 (143% of the target). Some of the short-term training programmes included training on case detection and management of TB, GeneXpert technology, fluorescent microscopy, line probe assay technology, leprosy diagnosis, biosafety cabinet servicing, second-line drug susceptibility testing, GeneXpert proficiency testing panel preparation, quality-management systems, biosafety and biosecurity, leadership, and governance. Staff at the OHSI have been supported to develop their skills through long-term courses. One doctor has completed studies in radiology (Master of Medicine in Radiology), one radiographer upgraded to degree level

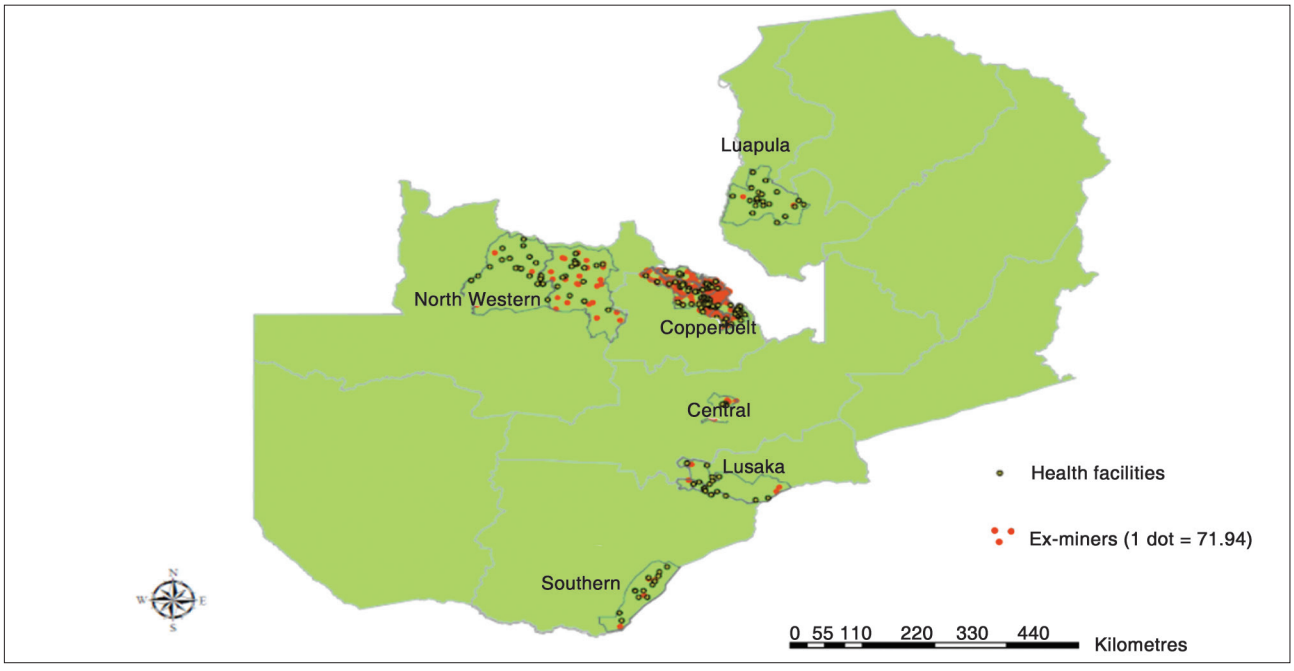

Figure 4. Distribution of health facilities and ex-miners in the mapped districts

in radiography, one occupational hygienist upgraded to a Master's in Occupational Safety and Health (OSH), one laboratory technologist upgraded to a Bachelor of Science degree in biomedical sciences, and one doctor is pursuing a Master of Medicine in Pathology. This has improved local capacity and efficiency of the CoE in serving the local and regional needs.

Laboratory staff are now able to diagnose TB on different platforms through skills gained in microscopy and GeneXpert (testing and maintenance). Staff from the three culture laboratories gained specialised skills in line probe assay (LPA) and drug susceptibility testing (DST). Other skills gained include leprosy diagnosis and biosafety cabinet servicing. The Chest Disease Laboratory (CDL) is now able to prepare its own in-country GeneXpert proficiency testing (PT) panels after three staff members were trained at the Uganda Supranational Laboratory. The CDL is now ready to apply for ISO17043 accreditation.

Sub-component 2.2: Strengthening diagnostic capacity and disease surveillance

Laboratory systems strengthening and accreditation

The regional project delivered substantial achievements through various interventions, including the procurement of new molecular diagnostics such as GeneXpert, digital X-rays with artificial intelligence-enabling features, and use of mobile diagnostic units to increase access to TB diagnosis and treatment. These public health diagnostics investments have led to increased use of WHO-recommended TB diagnostics.

The low leprosy notification and high rates of patients presenting with severe disability point to poor awareness about leprosy in the community, delay in presentation, and poor skills to diagnose leprosy among healthcare workers. Therefore, a deliberate move was made to prioritise capacity building in the diagnosis of leprosy by laboratory personnel.

Stepwise Laboratory Improvement Process Towards Accreditation (SLIPTA)

In 2017, baseline audits were conducted in 19 laboratories supported by the SATBHSS project, in all 10 provinces of Zambia. Seven have been taken up by the accreditation/certification programme under the Laboratory Services Unit of the MoH, four are undergoing mentorship in order to apply for ISO15189 accreditation, three are undergoing certification mentorship, and the three TB culture facilities achieved, and have maintained, their ISO15189 international accreditation under the SADC Accreditation Services (SADCAS).

The ECSA-HC contributed to building capacity of project countries to implement laboratory system strengthening and quality-management systems towards accreditation, through training and certification, using African Society for Laboratory Medicine (ASLM) SLIPTA-certified auditors.

Procurement of laboratory commodities/consumables and equipment

The sputum courier system was strengthened by the procurement of packaging accessories and an additional 60 motorbikes. There are now 349 motorbikes available in the districts. Fifty-two GeneXpert machines were procured under the project, bringing the total number in the country to 340, and resulting in improved access to WHO-recommended rapid diagnostic tools. The expansion of GeneX-pert sites and sustained provision of cartridges have contributed to an increase in the number of bacteriologically confirmed TB cases detected, and has improved the turn-around time for results from seven days in 2016 to 24 hours since 2020. This has significantly contributed to timely commencement of quality TB treatment and care.

With the addition of GeneXpert machines came an increase in testing among presumptive TB patients, from 90 979 in 2017 to 249 873 in 2020 (Figure 5), and an increasing trend in bacteriologically confirmed cases, from 16 443 in 2017 to 18 768 in 2020.

The CDL is now able to produce its own expert proficiency testing panels and has enrolled 100 sites. This reduces the cost of procuring commercial panels for the country. The new negative air pressure ventilation system at the CDL is the first of its kind in Zambia in a public facility. The three culture laboratories have maintained their accreditation and have received awards of recognition for this.

Disease surveillance, preparedness, and response

The SATBHSS project supported the Zambia National Public Health Institute (ZNPHI) to implement a number of disease surveillance activities, in line with its mandate of maintaining national public health security as from 2018. Notable activities included the establishment of cross-border disease surveillance committees between Zambia and the Democratic Republic of the Congo, Malawi, Tanzania, Zimbabwe, and Mozambique for preparedness and response to epidemics or other events of public health concern. Some of the disease outbreaks and threats investigated were cholera, COVID-19, Ebola virus disease, polio, typhoid, anthrax, and measles. The ZNPHI was able to develop and roll out an electronic version of the Integrated Disease Surveillance and Response (e-IDSR) in six provinces.

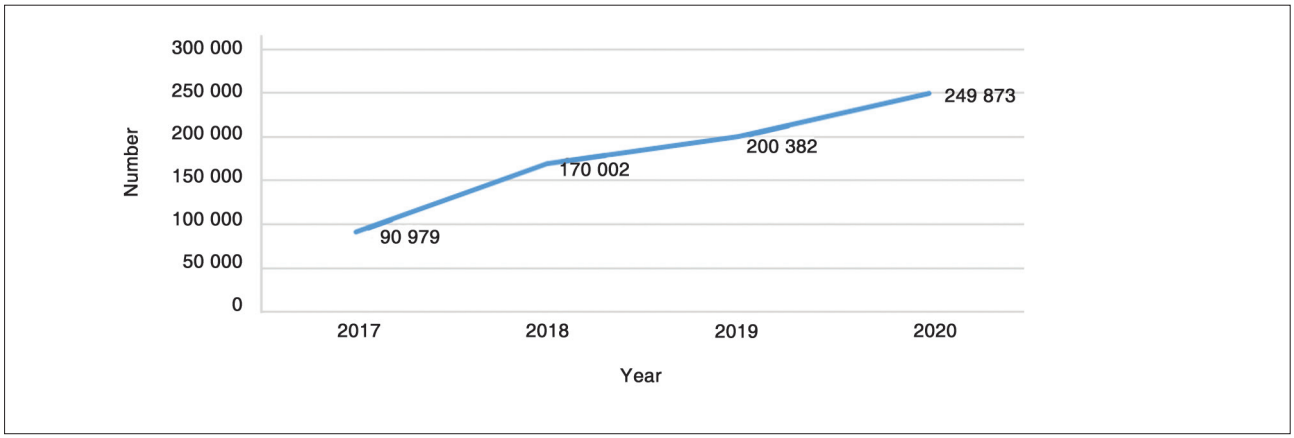

Figure 5. Number of GeneXpert tests per year

Sub-component 2.3: Strengthening mine health regulation

The MLSS Cabinet approved the Workers' Compensation Act amendment to allow miners with TB to return to work after successful treatment, provided they are certified fit. However, this is yet to be tabled in Parliament as the new Government requested time to review the draft Act. Further, the Ministry reviewed the Factories Act to include advances in OHS equipment, incorporating issues raised in the ILO Convention on Enterprises and ILO Convention no. 155.

The National Occupational Safety and Health Policy was developed and launched on 28 April 2023. The policy covers all sectors to comprehensively address the requirements, functions, and roles of stakeholders, including public institutions, employer and worker organisations, and research institutions. It mainstreams OHS in all sectors and reinforces the promotion of decent work in the country.

It was observed that inadequate OHS management practices contributed to illnesses, accidents, and injuries at work because Zambian guidelines for dust and noise levels were not specific enough. The SATBHSS project supported the development of occupational hygiene standards on dust and noise limits. A training manual on dust control in the mines was developed, and 53 mine health and safety representatives were trained.

Under the MMMD, the MSD has been able to review the Explosives Act of 1973 and the Mining Regulations Act of 1971, both of which are outdated. The Explosives Act is due for presentation to the Minister en route to Parliament. The Mining (Environmental) Regulations and the Environmental Protection Fund Regulations are to be presented to the Minister for signing into Statutory Instruments. However, the process has been delayed because of the creation of the Minerals Regulatory Commission, which has split the Mines and Minerals Development Act into two Acts – one to be used by the Commission and the other by the Ministry. All new Acts have been drafted and the Minerals Regulatory Commission Bill has been presented in Parliament for debate and enactment. Table 1 provides an overview of the status of the various legislations.

Component 3: Regional learning, innovation, and project management

Sub-component 3.1 Operations research and knowledge sharing

From inception, the SATBHSS project allocated funds to support regionally and nationally commissioned operational research. Three regional and nine national studies were commissioned to enhance innovation in TB and OLD control, and to inform policy and practice through innovative knowledge-sharing approaches.

Sub-component 3.2 Centres of excellence in TB and occupational lung disease control

The Centre of Excellence on Occupational Health and Safety

The SATBHSS project supported the four Government institutions in Zambia, namely, the MSD, OHSI, WCFCB, and OSHSD, to become the CoE on OHS to serve the country and the needs of the SADC region. The CoE is responsible for primary, secondary, and tertiary prevention in mining areas. It offers primary prevention services that include mine inspections, hazard identification, risk assessments, and the implementation of an OHS management system across the mining industry. Secondary and tertiary prevention are provided by the OHSI and WCFCB authorities. The OHSI covers the greater part of the mining industry and provides occupational health surveillance and impairment evaluations for workers. The WCFCB provides compensation of workers for disabilities suffered or diseases contracted during the course of employment.

Training and capacity building under the Centre of Excellence

Capacity building for OHS formed a big part of the project under the CoE, with support from the SATBHSS project, AUDA-NEPAD, and ECSA-HC. All medical officers from the OHSI were trained in the ILO International Classification of Radiographs of Pneumoconioses. The adoption of this system in the OHSI operations improved the diagnosis of pneumoconiosis among miners and ex-miners. An additional 44 doctors from mining districts in Zambia, and 93 from the region (Angola, Botswana, Democratic Republic of the Congo, Eswatini, Lesotho, Madagascar, Malawi, Mozambique, Namibia, South Africa, Tanzania, and Zimbabwe) were also trained in the recognition of OLDs using the ILO Classification system.

Training of occupational hygienists was prioritised by the CoE as the region lacked certified occupational hygienists. The Occupational Hygiene Training Association programme was used for the training of officers from the OHSI, MLSS, and MSD. Risk assessment is the foundation of any health and safety programme, and the programme provided capacity building of occupational health practitioners, mines, and labour inspectors. Thirty-three staff from the three agencies were trained from 2018 to 2023.

Table 1. Legislative reforms

Legislation	Status	Comment
Mines and Minerals Development Act	First round of stakeholder consultation complete	Change of Government meant change of policy; thus, two new Acts are in the process of enactment and this Act will be repealed and replaced
Explosives Act	Cleared by Justice Dept.	Waiting for Cabinet approval before Parliament debate and enactment
Mining (Environmental) Regulations	Cleared by Justice Dept.	Waiting for launch by the Minister
Environment Protection Fund Regulations	Cleared by Justice Dept.	Waiting for launch by the Minister
Mine Safety (Inspection and Examination) Regulations	Second draft in place after first stakeholder consultation	Draft Regulations in place, awaiting clearance by Business Regulatory Authority, then Ministry of Justice, before launch by the Minister
Workers' Compensation Act	In progress	Awaiting Cabinet approval before tabling in Parliament
OHSI Act, OHSI Regulations	In progress	Awaiting stakeholder engagement of introduction of fees
Factories Act	In progress	Draft Bill awaiting Cabinet approval
OHS Policy	Completed	Implementation plan and policy officially launched

Short-term training was provided in spirometry, audiometry, and vision screening (12 nurses and doctors were trained). Four technicians were trained in dust analysis and four mine and labour inspectors were trained in research and manuscript writing. Health and safety committee representatives were trained in OHS concepts, with a focus on dust management. District Labour Officers were trained on compensation and OHS concepts to enhance their knowledge and skills for inspections in that area.

Impact of the Centre of Excellence

Most of the interventions planned have been implemented in a timely manner. The availability of trained human resources and the procured state-of-the-art equipment have enhanced the efficiency and effectiveness of service delivery at the CoE. The OHSI in Kitwe expanded its coverage by opening up new OHS centres in Lusaka (in 2019) and Solwezi (in 2021). The investment made by the project in equipment and infrastructure, and the opening of these new sites, have contributed to improved access and quality of OHS services in the country, targeting miners, ex-miners, and non-mining sectors (factory workers, agriculture, drivers, contractors, food handlers etc.).

The increased access, coverage and quality of OHS services has improved performance of the CoE over the years, especially in the areas of medical surveillance, OHS examinations and certification, joint inspections of mines, compensation for miners and ex-miners with work-related disabilities, and human resource capacity development. Additionally, waiting times from initial screening to examination have decreased.

Figure 6 illustrates the impact of the CoE-OHS interventions in the mining industry from 2015 to 2022, where the number of reportable and fatal accidents dropped, more steeply in 2018, due to an increase in inspections, training, and advisory interventions.

The purchased dust sampling equipment necessitated a robust exercise in dust-generating mines, to ensure that sampling was conducted and real-time data recorded and reported. This equipment helped the Inspectorate to cover mines that do not have the capacity to monitor dust levels in the workplaces, and then make informed decisions about appropriate control measures to safeguard employees. Control measures included changes in design and provision of appropriate personal protective equipment (PPE), which were sanctioned after inspection and dust sampling exercises. For example, the Inspectorate team visited Neelkanth Lime Limited during routine inspections and dust sampling. Around 182 employees were working without respirators in dusty work environments, verified with spot dust samplers procured under the project. The Inspectorate immediately withdrew the employees from the site and directed the mine management to immediately issue them with respirators.

Efficiency in project implementation

Throughout implementation, the project ensured that financial resources were allocated and utilised effectively to achieve the project objectives in a timely and cost-efficient manner. This involved the strategic allocation of funds to ensure that budget allocations within the project components were aligned with project priorities, goals, and activities outlined in the project plan. Resources were strategically allocated to areas with the highest impact and greatest need, such as innovative prevention and detection of TB, epidemic preparedness and response, capacity building, infrastructure development, procurement of essential supplies, and implementation of key interventions.

Cost-effective procurement practices

The project implemented cost-effective procurement practices to maximise the value of project funds, which included conducting competitive bidding processes, negotiating favourable terms with suppliers, leveraging economies of scale, and avoiding unnecessary expenditures.

Transparent financial management

The project established transparent financial management systems and procedures to track budget expenditure, monitor financial performance, and ensure accountability. Accurate records of expenditures, receipts, and financial transactions were maintained, and financial reports were regularly reviewed to identify variances, discrepancies, or potential areas for improvement.

Efficient utilisation of resources

The utilisation of project resources was optimised, including human resources, equipment, and facilities, to maximise efficiency and productivity. Resources were allocated based on workloads,

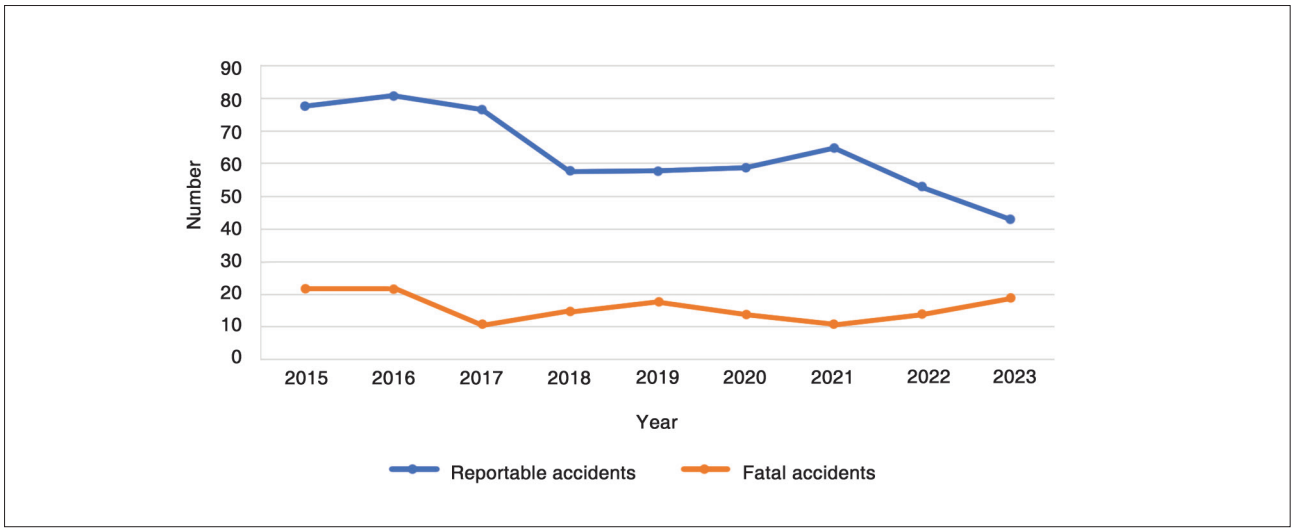

Figure 6. Trends in reportable and fatal accidents, 2015–2023

priorities, and project needs, and minimised wastage or duplication of efforts. Measures to streamline processes, eliminate bottlenecks, and improve workflow efficiency were implemented.

Timely implementation of activities

Activities were implemented according to schedules and within budgetary constraints. Delays, obstacles, or resource constraints that could have impeded progress were identified and addressed; proactive measures were taken to keep the project on track. Critical activities and resource allocation were prioritised to meet project deadlines and milestones.

Monitoring and evaluation of expenditures

Expenditures were regularly monitored and evaluated to assess efficiency and effectiveness of project implementation. This was done internally and externally during the World Bank implementation support mission, to evaluate the impact of budget allocations on project outcomes, outputs, and deliverables, and to identify lessons learned and best practices for future budget planning and management. Feedback from monitoring and evaluation activities, including implementation, was used to improve budgeting processes and enhance project efficiency over time.

The CoE-OHS procured modern digital X-rays to replace the analogue X-ray machines previously in place, which led to improved diagnosis of OLDs. The project invested in GeneXpert and digital X-rays, and mobile clinics, which assisted patients far from health facilities and laboratories.

A regional TB out-of-pocket expenditure survey was undertaken in the participating countries to understand the costs associated with TB treatment, so as to inform better TB control strategies and interventions.

Project implementation arrangements were efficient, with government ministries taking the lead in implementation cost saving. Strategic experts were recruited to build capacity in-house and transferable capabilities to the national TB programmes. The country transferred resources to districts through a performance-based framework and empowered ownership and bottom-up planning with the end user in mind. The World Bank also utilised existing country bank structures. Local technical assistance was utilised where capacity at regional or country level was available.

Despite these successes, it is worth noting that the changes in Government affected the project implementation. A number of procurement activities were either delayed or put on hold until the transition period was complete, which significantly affected the achievement of some key deliverables, especially civil works and the procurement of equipment.

FACTORS THAT AFFECTED IMPLEMENTATION AND OUTCOMES

Factors that positively affected implementation

- Strong multisectoral collaboration among the implementing agencies' technical teams
- Use of multisectoral teams in conducting mine inspections resulted in more mines reached within a short timeframe
- The integrated approach to OHS service delivery of the primary, secondary, and tertiary services, all housed in one place
- Strong political will from Ministers in the three ministries of health, mines, and labour to ensure that the project was a success
- Strong support from the respective Permanent Secretaries and senior management, as evidenced by their participation in National Technical Committee meetings
- Buy-in by various stakeholders at all levels of service delivery, from community to national levels
- Strong linkages created with mining companies, local and regional learning institutions, and organisations that promoted knowledge exchange and skills development

Key factors during preparation and design

A few factors delayed the project's effectiveness:

- The Zambia SATBHSS project delayed completing, submitting, and getting approval of the Project Appraisal Document (PAD)
- The project only became effective in March 2017, which delayed disbursement of funds
- Delayed staff recruitment for the Project Implementation Unit (PIU) resulted in delayed initiation of activity implementation
- Each implementing agency identified staff as focal points persons to be on the project; key positions, such as the accountant and internal auditor, were seconded by the MoH to support the project at no added cost to the project

Key factors during implementation

Despite the achievements of the project, there were factors during implementation that either facilitated or hampered success. These were documented based on key informant interviews. There are opportunities for future programmes to develop risk-mitigation plans. Some of key factors included:

- Delayed project effectiveness, recruitment of PIU staff, and release of funds affected start-up of activity until September 2017.
- Equipment and civil works were grossly under-budgeted. This led to extended time spent obtaining approval for budget adjustments, which subsequently caused delays in initiating procurement and service delivery.
- High staff turnover at district and facility levels affected activity implementation.
- High turnover among TB treatment supporters/volunteers was evident, due to lack of remuneration.
- Outbreak of epidemics, such as cholera and COVID-19, resulted in deviating resources from approved activities that had to be suspended.
- The COVID-19 pandemic and associated control restrictions by the Government on movement and gatherings, such as training events, affected project implementation.
- Prolonged procurement processes and approvals resulted in delayed acquisition of services and equipment.
- The suspension of the MoH's Procurement Department for nearly a year, due to administrative reasons, caused significant delays in procurement and service delivery.
- Administrative changes at the MoH delayed the approval of programmes and procurement of goods and services.
- Approval of designs of infrastructures and bills of quantities were given by other ministries, but took longer than expected; the project had no control over the mandate of other ministries, which impacted the programme schedule.
- Prolonged delays in the review and approval processes for no objection by the World Bank affected the implementation of activities, especially the infrastructure designs for key buildings needed to enhance service delivery for screening and examination, and actualisation of the CoE-OHS.
- Delayed infrastructure completion, partly due to delays in payments, delayed the installation of major dust analysis equipment and other laboratory services needed to enhance OHS programmes in the country.

- Prolonged legislative and regulatory reforms hindered the implementation of changes that could have enhanced service delivery and increased benefits for the project beneficiaries.
- The absence of legislation to regulate and/or support the operations of artisanal and small-scale miners prevented them from accessing OHS services amidst excessive dust exposure.

SUSTAINABILITY

Sustainability is essential for healthcare projects to achieve lasting improvements in health outcomes. Optimising the use of resources ensures that investments in TB control and health systems strengthening in Zambia continue to yield benefits in the long term. Maximising the impact of investments in health projects requires sustained efforts to maintain and build upon the progress achieved during the project's implementation. The SATBHSS project had many elements of sustainability embedded during implementation. The project was mainstreamed within the existing government structures, which ensures sustainability of the project interventions through government funding. In addition, each implementing agency ensured that the milestones created through the project will be sustained.

Ministry of Health National TB Control Programme

The project contributed to the strengthening of the overall health system in Zambia to ensure that TB control efforts are integrated into broader health service delivery platforms. This involved improving infrastructure, notably the construction and renovation of health facilities, and supply of state-of-the-art equipment. The project enhanced supply chain management, human resource capacity building through short- and long-term training, and information systems to support sustainable TB diagnosis, treatment, and care services within the existing healthcare infrastructure.

Mines Safety Department

The MSD has drafted an instrument to enable statutory services rendered to be paid for by mining license holders. The legislation is in its final form and is waiting for the approval of a new law that will see the creation of the Minerals Regulatory Commission. The objectives of the drafted statutory instruments are to provide for the sustainable administration and enforcement of safety, health, and environmental protection laws in the mining industry, and to enhance service delivery by the MMMD.

The MSD has streamlined its funding to include OHS-related inspections in the mining and mining-related sectors. It has also taken over the maintenance of vehicles procured under the project and will ensure that funding is available for consumables for equipment bought under the project. The MSD will continue to collaborate with other institutions at the CoE to ensure an integrated approach to increasing capacity of occupational hygienists in the country, and increased research on OHS, to protect workers against OLDs and TB.

Centre of Excellence on Occupational Health and Safety

The CoE-OHS was designed to be implemented primarily through existing public institutions such as the MSD, OHSI, WCFCB, and OSHSD. This implementation model created a foundation for sustainability and for the Government to maintain activities within its institutions and resource environments, after the closure of the SATBHSS project. The CoE activities are sustainable, especially since there is adequate capacity being built in OHS coupled with the procurement of state-of-the-art equipment.

The sustainability plan outlines strategies, governance, current efforts, goals, and targets for key operational initiatives, and opportunities for delivering OHS services at the COE-OHS. The aim is to chart the trajectory of self-sustenance of the CoE-OHS, by adopting and implementing value-adding initiatives that embody the four major perspectives of the balanced score card, i.e. internal processes, learning and growth, people, and finances. It further clarifies the modus operandi for quality improvement, financial adequacy, skills, and human resources.

LESSONS LEARNED AND RECOMMENDATIONS

This SATBHSS project Zambia ICR report highlights major successes in TB and OHS programming, and challenges that need to be tackled. Table 2 summarises the lessons learned and recommendations for improvement.

Table 2. Lessons learned and recommendations for TB and OHS programming

Lesson 1: Healthcare workers screening programme
1. Most of the healthcare workers that were identified as having TB were seemingly healthy, yet they had TB active disease. 2. The source of TB disease in health facilities is multiple, including undiagnosed patients in the communities, fellow healthcare workers with undiagnosed TB, and guardians. 3. Early TB case detection and routine screening are helpful strategies for reducing nosocomial transmission in areas with either low or high TB incidence. 4. Accurate and timely diagnosis of TB disease is essential to ensure correct and appropriate patient care and public health responses. 5. Most of the staff who volunteer to be screened for TB are juniors, so the number of healthcare workers diagnosed with TB is not an accurate representation. **Recommendations** 1. Consistency in annual screening and awareness-raising are critical elements in addressing hesitance and creating demand for TB screening services. 2. Confidentiality is critical in building trust and motivating healthcare workers to undergo screening for TB.
Lesson 2: Implementation of the results-based financing programme
The national TB programme implemented results-based financing (RBF) in 19 districts with support from the SATBHSS project. Since 2019, the initiative has been a game-changer in efforts to control and reduce the burden of TB, with the potential to minimise or even eradicate the disease. The approach relies on community-based volunteers, who are embedded in the communities where missing cases are identified. This proximity facilitates the timely detection and referral of cases to healthcare facilities for further investigation. Regarding RBF, a key consideration is whether to build a new system from scratch or leverage existing systems, as each option has cost implications. This was evident in the in the SATBHSS project; due to inadequate planning, its community RBF efforts were prematurely suspended.

Lesson 3: Availability of qualified personnel
The project proved that operations that had qualified managers and support staff implemented primary, secondary, and tertiary interventions more effectively than those that did not have these staff. Operations that had well-structured safety, health, and environment sections handled OSH matters robustly. Effective monitoring of workplace dust requires trained and qualified personnel, who can assess the conditions at each workstation and provide feedback on the effectiveness of intervention measures. **Recommendations** It is important for the industry to have personnel with diverse qualifications if OSH matters are to be adequately addressed.
Lessons 4: Training needs
Review of training needs of employees and the Inspectorate was key in accelerating the enforcement and implementation of primary, secondary, and tertiary interventions for better OSH environments. **Recommendations** Training needs of employees should be periodically reviewed to accelerate the enforcement and implementation of primary, secondary, and tertiary OHS interventions.
Lesson 5: Knowledge sharing
Knowledge sharing among project partners accelerated the implementation of project goals, and provided a platform for reviews of implementation strategies to better manage the mining and mining-related sectors. **Recommendations** Improve knowledge sharing among project partners to accelerate the implementation and attainment of project goals
Lesson 6: Stakeholder engagement and management
The success of the project was mainly centred on the good reception of the concept by all stakeholders, especially the mining sector. Well-crafted stakeholder engagement and management led to significant industry investments, aimed at either reducing dust emissions in the workplace or containing dust to minimise exposure. These measures improved compliance levels in the sector.
Lesson 7: Medical surveillance
Access to medical surveillance at initial and every other stage is key for all operations. Availability of such services across the country helps to determine the effectiveness of the intervention measures by the Inspectorate team. During the project life, mobile screening services and the establishment of two screening centres in Lusaka and Solwezi by the OHSI were milestones, used to track the success of intervention measures undertaken during the project.
Lesson 8: Occupational health and safety support
Occupational health and safety support provided through infrastructure, training, and equipment procurement was transformative to the regional SATBHSS project. This support led to the establishment of OHS clinics, specifically targeting mining companies and communities. **Recommendations** 1. Zambia's OHSI, as a CoE, needs to be sustained to continue as a critical resource in the broader southern Africa region, and beyond. 2. There is an urgent need to adopt and finalise the pending OHS legislations to increase the benefits of mine safety, compensation, and other OHS policies. 3. The OHSI, through its sustainability plan, should develop its market-shaping strategy for OHS services in the region, and income-generating activities. 4. Investment in a robust data system and collection procedures, including digital health systems (transition from a manual system), is necessary for OHS in mining areas.
Lesson 9: Training and capacity building
Training and capacity building were central to the SATBHSS project's success, with 5 989 personnel trained in Zambia through short- and long-term training programmes supported by the project. This initiative has contributed to establishing a competent and sustainable workforce for managing TB and OHS. The combination of training and mentorship proved effective in ensuring that learning took place and was cascaded to lower levels, as demonstrated in the laboratory accreditation SLIPTA process. **Recommendations** 1. Future training and capacity-building project components should be periodically evaluated. 2. There should be a shift to competence-based training curricula at regional and country levels, linked to quality improvement; gaps should be identified and targeted with refresher trainings. 3. The use of e-learning platforms or hybrid practical approaches such as Extension for Community Health Outcomes (ECHO) should be used to deliver training; costly physical training platforms should be avoided.
Lesson 10: Collaboration
Multi-sectorial collaboration between the ministries of health, mining, and labour, and external partners, was instrumental in accelerating project components and outcomes.
Lesson 11: Research
Operational research complemented and informed evidence-based interventions for TB and OHS. Twelve studies have been completed in Zambia; findings were disseminated in national and international forums. These studies have expanded the knowledge base for practitioners and will be key in enhancing better decision-making for both ongoing and future initiatives. The research studies were aligned to country TB and OHS research priorities, to some extent. Some contributed to policy changes. **Recommendations** 1. These research findings should be disseminated to lower levels and utilised for funding applications. An example is the TB out-of-pocket expenditure studies in countries that had recommendations for reducing financial burdens on TB patients, by using health insurance and social protection measures; however, limited work has been undertaken in countries to drive this. 2. Consideration should be given to conducting more action/implementation research that is strongly linked to local TB operational challenges, with the objective of finding local solutions. 3. The link between researchers and policymakers should be strengthened.
Lesson 12: Digital innovations
Zambia invested in digital health innovations, including TEST and a virtual TB situation room. These represent innovative approaches for utilising data science and connectivity to enhance visibility and decision-making in TB management. The ECSA-HC also played a supportive role in training countries on utilising data for action. **Recommendations** A clear pathway should be developed for scaling up of the digital health innovations launched in the country, and integrating these innovations with national health information systems for greater buy-in by Governments and sustainability.

CoE: Centre of Excellence, ECSA-HC: East, Central and Southern Africa-Health Community, OHS: occupational health and safety, OHSI: Occupational Health and Safety Institute, OSH: occupational safety and health, RBF: results-based financing, SLIPTA: Stepwise Laboratory Quality Improvement Process Towards Accreditation, TB: tuberculosis

CONCLUSION

The SATBHSS project timely supported innovative and progressive interventions over the seven years of implementation in Zambia. A number of achievements have been registered, challenges documented, and lessons learned from the implementation of the three project components, as described in this report. Consequently, the WHO has recognised Zambia's remarkable achievements in reducing TB incidence and mortality rates. Zambia has been placed among 83 nations, worldwide, that have recorded a decline in TB incidence of 20% or more from the 2015 baseline. Furthermore, Zambia has been recognised among 47 countries that have successfully reduced TB mortality by 35% or more. These achievements are a testament to Zambia's commitment to fighting TB and improving the overall health of its citizens.

The project has immensely supported Zambia on cross-border preparedness, the COVID-19 pandemic, and future disease outbreak responses, by the creation of a stronger, resilient health system. A number of public health assets were procured during the project, including state-of-the-art equipment. Laboratories were renovated and DR-TB wards were built. Additional benefits include improved laboratory and healthcare infrastructure, enhanced quality, and transformative support for OHS practices. This is demonstrated through a multi-disease approach, effective targeting of mining and related communities, and the introduction of innovations and CoEs. Furthermore, operational research studies are building evidence for future interventions.

Additional information about some of the issues presented in this report can be found at: https://practhealth.co.ke/wp-content/uploads/2024/05/Abridged-ECSA-HC-SATBHSS-ICR-Report.pdf

Report on the evaluation of the Regional Centre of Excellence in Occupational Health and Safety

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SUMMARY

The Republic of Zambia is one of the four participating countries in the Southern Africa Tuberculosis Health Systems Support (SATBHSS) project. The others are the Republic of Malawi, the Kingdom of Lesotho, and the Republic of Mozambique. With support of the project, Zambia established the Centre of Excellence (CoE) in Occupational Health and Safety (OHS) in 2018 with the following objectives: to improve the quality of medical and work environment surveillance for the prevention and early detection of occupational lung diseases, including tuberculosis (TB), in Zambia and the sub-region by 2021; to improve capture, storage, analysis, and use of data at the Occupational Health and Safety Institute (OHSI) through an integrated central management system by 2019; to increase human resource capacity and skills in selected fields in occupational health and safety (OHS) and TB by 50% at the OHSI, to support Zambia and the sub-region by 2019; and to develop a patient-centred approach to occupational health examinations (remodelling OHSI services to focus on informing miners about their health) at the OHSI by 2019.

To achieve these objectives, the CoE brought together the Ministry of Health, the OHSI, the Ministry of Labour and Social Security, the Ministry of Mines and Mineral Development, and the Workers' Compensation Fund Control Board (the Consortium).

The multiple changes and systemic gaps in Zambia and the other SATBHSS-participating member states, in the provision of occupational health services and occupational hygiene, motivated the creation of the CoE. These included inadequate human resources coupled with low proficiency in the provision of occupational health services, limited access to occupational health services, lack of specialised equipment, and dilapidated infrastructure.

The East, Central and Southern Africa-Health Community (ECSA-HC), together with the African Union Development Agency-New Partnership for Africa's Development (AUDA-NEPAD) and the country team, conducted an evaluation of the CoE with the objective of documenting the outcomes of interventions implemented under the CoE – and the lessons learned.

The evaluation of the CoE revealed that it was an excellent, paradigm-shifting concept, and is essential in the provision of occupational health services. Under the CoE, routine occupational health services have been decentralised to the North-Western and Lusaka provinces, and to other Zambian provinces through outreach services. The number of medical surveillances increased by 6% in the first year of implementation of the CoE from the baseline year, 2017. The increase in medical surveillance was sustained until 2020, when the CoE was affected by the COVID-19 pandemic.

The number of cases compensated increased from about 90 in 2018 to at least 130 in 2022. The CoE provided support to other SATBHSS member states, mainly in human resource development. The CoE was open to other countries in chest radiography reading training, as Zambia is the only one of the four countries with B-reading equipment. The procurement of assorted equipment enabled the execution of specialised services.

The objectives of the CoE have been achieved. It has been enabled and capacitated to provide much-needed essential and specialised occupational health services. Each of the member institutions of the Consortium provided strategic and complimentary services, contributing to the goals and objective of the CoE. The CoE has huge potential to scale up its operations, as a firm foundation has been laid and most of the essential equipment is available. Key to the sustainability of the CoE is the completion of the remaining infrastructural works and the Strategic and Sustainability Plans.

Front Row from left: Mr Norman Khoza, Dr Kingley Ngosa, Dr Bernedict Mushi, Prof. Dingani Moyo. Back Row: Dr Patrick Lungu, Ms Patricia Chilaisha, Prof. Muzimkhulu Zungu and Mr Zakeyo Mvula

Photograph: courtesy of the AUDA-NEPAD

INTRODUCTION

The Republic of Zambia has made tremendous progress in reducing the high burden of tuberculosis (TB), which is responsible for at least 40% of deaths among people living with the human immunodeficiency virus (HIV) in the country. As a mining country, Zambia also has an extremely high risk of developing occupational lung diseases. In the last five years, Zambia has accelerated the fight against TB, thanks to both international and domestic funds provided by the donor community and the Government of the Republic of Zambia. The prevalence of TB has decreased substantially, through concerted efforts anchored in a multi-sectoral approach.

One of the objectives of the SATBHSS project is to build regional capacity in TB and occupational health. Each of the participating countries has an area of focus under the umbrella of the centres of excellence (CoEs). Lesotho established a CoE in community-based drug-resistant TB (DR-TB) care, Malawi in community TB and integrated disease surveillance, Mozambique in the management of DR-TB and paediatric TB management, and Zambia in occupational health and safety (OHS).

The CoE for Zambia has been implemented under a Consortium within two ministries: 1) the Ministry of Labour and Social Security (MLSS) responsible for three CoE institutions (the Occupational Health and Safety Institute (OHSI), Occupational Safety and Health Services Department (OSHSD), and Workers' Compensation Fund Control Board (WCFCB)); and 2) the Ministry of Mines and Mineral Development (MMMD), which is responsible for the Mine Safety Department (MSD).

The OHSI is mandated by the Workers' Compensation Act No. 10 of 1999 to carry out medical examinations of all prospective, current, and former miners in Zambia. The Occupational Health and Safety Act No. 36 of 2010 expanded this mandate to include other industries, but this has not yet been operationalised. The OHSI administers initial, periodic (annual), discharge, and post-career medical examinations of miners, and is charged with analysing and reporting surveillance data on occupational lung diseases in the mining sector.

Examinations of miners working in the Copperbelt province are performed at the OHSI facility, while miners from other provinces are offered services through mobile outreach programmes run by OHSI staff. All examinations include the recording of medical and occupational histories, a physical examination, a chest X-ray, and a pulmonary function test (spirometry).

Miners deemed unfit for work at the initial examination are either deferred (pending further examination) or rejected permanently; miners deemed unfit for work during periodic examinations are referred to a hospital for treatment or are 'certified' as having lung disease resulting from their work, making them eligible to apply for workers' compensation.

Before the establishment of the CoE for OHS, the country experienced the following challenges:

1. High patient volume incommensurate with staffing levels, which compromised quality of clinical services for public health action
2. Absence of standardised criteria for exclusion from work
3. Outdated radiography equipment
4. Low proficiency in the classification of chest radiographs for occupational lung disease
5. Workflow practices that introduced bias into the radiograph classification process
6. Limited capacity for the OHSI to conduct outreach and examinations for miners working in geographically remote provinces
7. Digital and paper-based information management systems and lack of data back-up systems

Objectives of the Centre of Excellence

The implementation of the CoE started in 2018. Its main objective is to attain the highest capacity in prevention, diagnosis, medical surveillance, capacity building, and research in occupational lung diseases and TB, including the promotion of health and safety in the mining sector by 2021. The ECSA-HC, in collaboration with the country team, documented the CoE's performance.

Specific objectives

1. To improve the quality of medical and work environment surveillance for the prevention and early detection of all cases of occupational lung diseases, including TB in Zambia and the sub-region by 2021
2. To improve data capture, storage, analysis, and use at the OHSI through an integrated central management system by 2019
3. To increase human resource capacity and skills in selected fields in occupational health and safety, as well as TB, by 50% at the OHSI, to support Zambia and the sub-region by 2019
4. To develop a more patient-centred approach to occupational health examinations (remodelling OHSI services to focus on informing miners on their health) at the OHSI by 2019

EVALUATION OF THE CENTRE OF EXCELLENCE

The aim of the evaluation was to document the outcomes of the interventions implemented under the CoE.

Objectives

1. To assess progress towards achieving the objective of establishing the CoE
2. To explore the functionality of the model used to implement the CoE (consortium approach)
3. To assess the performance of the CoE in terms of service coverage, quality of service, data capture, and human resource capacity
4. To assess the impact of interventions on clients (beneficiaries)
5. To assess the prospects for sustainability of the CoE interventions post the SATBHSS project.
6. To document lessons learned, and challenges and barriers to implementation

METHODS

Both qualitative and quantitative methods were used for the evaluation of the CoE, which involved key informant interviews of strategic stakeholders and the use of structured intermediate outcome indicators. Trends in the number of workers screened for, and diagnosed with, occupational diseases, and the numbers submitted for compensation, were analysed. Using a structured questionnaire, we assessed the relevance of the CoE, existence of policies, regulations, and guidelines; and documented achievements, challenges, and gaps. We also assessed satisfaction of recipients of service. Other methods of assessment included desk reviews of documents, data mining, and on-site data validations.

RESULTS

Relevance of the Centre of Excellence and progress towards achieving its objectives

The SATBHSS project supported the four government institutions in Zambia (the MSD, OHSI, WCFCB and OSHSD) to become the CoE for OHS to serve the country and the needs of the SADC region.

The CoE is responsible for primary, secondary, and tertiary prevention of diseases and injuries in mining areas. It offers primary prevention services that include mine inspections, hazard identification, risk assessments, and the implementation of an OHS management system across the mining industry. Secondary and tertiary prevention are provided by the OHSI and WCFCB authorities. The OHSI covers the greater part of the mining industry, and provides occupational health surveillance and impairment evaluations for workers. The OHSI centres in Kitwe, Solwezi, and Lusaka ensure good coverage in the high mining areas in Zambia. The WCFCB provides compensation for disabled or sick workers.

The SATBHSS project supported procurement of state-of-the-art equipment, which included:

- Six digital X-ray machines
- A portable lead shield
- Nine sets of B-reading machines
- Two GeneXpert machines
- Two spirometry machines
- Two diagnostic audiometry machines
- Two BioChem-VacuuCenter (BVC) control fluid aspiration systems
- A light-emitting diode (LED) microscope
- A hematocrit machine
- A benchtop centrifuge
- An X-ray diffractometer (XRD) for analysis of dust samples
- Two gas analysers
- Five gravimetric dust samplers
- Two sound level meters
- A digital industrial weighing scale
- Three motor vehicles
- A bus
- Servers
- Examination couches
- Extension of Community Health Outcomes (ECHO) equipment

The project also supported infrastructure development – particularly renovations of old structures that existed at the OHSI centres in Kitwe and Solwezi. It also supported human resource capacity development under long-term and short-term training programmes, to boost the capacity of the participating institutions to carry out their functions as the CoE.

The CoE has transformed the OHS landscape in Zambia, improving access to, and equity in, occupational health services, while enhancing service quality. It has aligned the operations of the key institutions involved in OHS service provision (the OHSI, WCFCB, OSHSD, and MSD). Additionally, the CoE has established strategic partnerships with Copperbelt University for research and human resource development in occupational health and hygiene.

The CoE united multiple institutions under a common agenda, breaking down the 'silos' that previously existed. As the central coordinating body, the CoE improved data sharing among Consortium members, enhancing their ability to deliver occupational health and compensation services. This collaboration has fostered greater appreciation of each institution's role, strengthening networking and enabling more comprehensive service provision.

The CoE established strong linkages with key institutions, enabling joint mine inspections that improved mine support and increased compliance with safety regulations. It also incorporated academia into a knowledge-sharing board that brings together experts and stakeholders. Additionally, the CoE enabled and facilitated the decentralisation of the provision of occupational health services across the country, which had not previously been possible. It mapped ex-miners with consultant support, facilitating targeted, cost-efficient service provision and raising awareness, resulting in a significant increase in compensated cases. The CoE has been a

strategic asset in building competencies in occupational health and hygiene across southern African countries, with the SATBHSS project-participating countries and other Southern African Development Community (SADC) countries receiving specialised A- and B-reading training in radiology.

Efficiency under the Centre of Excellence

Most of the planned interventions have been implemented in a timely manner. The availability of trained human resource staff and state-of-the-art equipment has enhanced the efficiency and effectiveness of service delivery at the CoE. The OHSI in Kitwe expanded its coverage by opening up new OHS centres in Lusaka (2019) and Solwezi (2021). This, in addition to investments in equipment and infrastructures, improved access and quality of OHS services in the country, targeting miners, ex-miners and workers in non-mining sectors (e.g. factory and agriculture workers, drivers, contractors, food handlers, etc.).

The increased access, coverage, and quality of the OHS services improved performance of the CoE over the years, especially in the areas of medical surveillance, OHS examinations and certification, joint inspections of mines, compensation for miners and ex-miners with work-related disabilities, and human resource capacity development.

The OHSI's mandate is to conduct medical examinations across all industries, investigate and detect occupational diseases and injuries, and refer workers with occupational diseases (including TB) to health facilities for treatment and to the WCFCB. The joint inspection of mines, under the umbrella CoE, promotes community sensitisation and awareness, leading to improved compliance with mining health and safety regulations, thereby increasing the numbers of miners and ex-miners screened, and the number of ex-miners compensated from 2018 to 2022; 570 claims were approved and 58 were rejected.

Human resource development

Capacity building of doctors, nurses, and occupational hygienists has included spirometry and audiometry skills training, basic occupational health services, and the International Labour Organization (ILO) International Classification of Radiographs of Pneumoconioses. The radiology staff, occupational health technicians, and occupational hygiene personnel are very competent in the performance of their duties. There is ongoing training and professional development of hygienists under the CoE. Forty-four local doctors have been trained in the ILO International Classification of Radiographs of Pneumoconioses; 19 officers have been trained in conducting baseline risk assessments in occupational settings.

The OHSI staff have also been supported to develop their skills through long-term courses, such as Bachelor's and Master's degrees, which has improved capacity and efficiency of the CoE in implementing its mandate of serving local and regional needs. The CoE has played a key role in building OHS capacity across the region, as originally envisioned. Since 2018, it has initiated short-term training programmes, training 94 doctors from Mozambique, Malawi, Lesotho, South Africa, and others in the ILO International Classification of Radiographs of Pneumoconioses. These programmes are expected to continue post the SATBHSS project, with the CoE signing a memorandum of understanding with the National Institute of Public Administration to offer a Diploma in Occupational Nursing. Similar efforts are underway with Copperbelt University to ensure the sustainability of these training programmes.

Centre of Excellence contribution to overall performance in the SATBHSS project

The investments under the CoE have contributed to improved performance in the SATBHSS project. The CoE was responsible for monitoring and reporting of performance indicators linked to project investments in OHS, including:

- TB case notification in target geographic areas
- TB cases identified through active TB case finding (screening) in vulnerable populations
- Miners and ex-miners successfully screened for occupational lung diseases
- Proportion of mines inspected at least twice a year, complying with national mine health regulations
- Numbers of miners and ex-miners successfully referred for continuity of treatment for TB and other occupational lung diseases, between and within participating countries

Effectiveness of the model used to implement the Centre of Excellence – the consortium approach

Although the concept of a CoE, involving three government ministries and four institutions, initially seemed complex and undesirable, it became evident that there were significant synergies between the organisations. While each maintained separate governance, they met the CoE's requirements through effective coordination of their OHS activities, facilitated by a capable and empowered administrator.

It is crucial for external audiences interacting with the CoE to understand its administrative, legal, governance, and service mandates to avoid confusion. The CoE brings together separate government institutions, each operating under mandates from Acts of Parliament to protect workers' health and safety in Zambia. Outside of the CoE, these institutions had shortcomings, such as duplication of efforts, inefficient resource use, and poor information sharing. Coordinating their activities under the CoE has improved efficiency and effectiveness.

Development of a strategic plan for the Centre of Excellence

The CoE-OHS, with technical assistance from the AUDA-NEPAD, developed a five-year implementation strategy, and a monitoring and evaluation plan. The strategy was reviewed by the Regional Expert Advisory Panel (REAP) appointed by the Permanent Secretary for the MLSS. Although some activities are being undertaken, the strategy is yet to be officially adopted by the Government. Some of the achievements are shown in Table 1.

Impact of the Centre of Excellence

The CoE has focused on strengthening systems for medical surveillance, OHS examinations, certification, and joint mine inspections to ensure compliance with health and safety regulations, and to provide compensation for miners and ex-miners. It also established an integrated information management system for better cross-sector data sharing. Investments in equipment, infrastructure, and new sites have improved access to, and quality of, OHS services, benefiting miners, ex-miners, and workers in non-mining sectors. The OHSI now conducts 200–300 medical examinations per day. The Zambian Government, through the CoE-OHS, has contributed immensely to the development of OHS in the region.

Impact of the Centre of Excellence on beneficiaries

The evaluation of the CoE included a client satisfaction assessment, with both miners and ex-miners providing feedback on the services offered. These results augmented findings from the Client Satisfaction

Survey conducted by the OHSI in 2022. The survey involved 295 respondents and evaluated satisfaction with various services, processes, and procedures.

Overall, responses indicated a positive experience with the process; the cleanliness of the facility, including the ablution block, was rated well. While 89% of respondents found the directional signage helpful, there is room for improvement to make navigation easier. Ex-miners were very satisfied with having separate examination facilities from current and prospective miners, which reduced feelings of stigma. They now feel more comfortable seeking medical services, benefiting from quicker, more private care. The annual TB and silicosis screenings were also appreciated, allowing clients to be examined for both occupational and other diseases.

Sustainability of the Centre of Excellence

The CoE was designed to operate through existing public institutions such as the MSD, OHSI, WCFCB, and OSHSD, creating a foundation for sustainability and allowing the Government to maintain activities when the SATBHSS project ends. The CoE is progressing positively towards sustainability due to the capacity building in OHS, and the procurement of state-of-the-art equipment.

Currently, the CoE is finalising a sustainability plan that outlines strategies, governance, goals, and targets for key operational initiatives, based on the balanced scorecard perspectives: internal processes, learning and growth, people, and financial perspectives. This plan aims to ensure self-sustenance by focusing on quality improvement, financial adequacy, and human resources.

In collaboration with the AUDA-NEPAD, the CoE engaged a consultant to develop the sustainability plan, along with a quality management plan and monitoring and evaluation plan. Key resource mobilisation activities and partners have been identified to support the CoE. The draft sustainability plan will be reviewed and endorsed by the REAP and the CoP-OHS in April 2023, in Lusaka, Zambia.

Based on the currently available resources (infrastructure, equipment, and human resources or available skill sets), the sustainability plan has four strategic areas of resources mobilisations, namely:

- **Capacity development** of both short-term and long-term attachment and mentorship programmes in partnership with local and international universities and research centres;
- **Laboratory services** in microbiology and occupational hygiene analysis, servicing the private sector (including mining);
- **Research and grants** in collaboration with local academic and research institutions and developmental organisations; and
- **Consulting services** in the public and private sectors through occupational health services, such as occupational hygiene monitoring, risk assessment, advisory services, research, etc.

CHALLENGES IN IMPLEMENTATION OF THE CENTRE OF EXCELLENCE

Despite significant achievements and improved performance under the CoE, several issues need to be addressed to enhance and sustain its operations beyond the SATBHSS project.

1. **Organisational structure:** The CoE lacks a clear governance structure and a designated lead agency. Although the OHSI has the necessary infrastructure and equipment, its potential leadership role in the Ministry of Labour and Social Security, which also houses the OSHSD and WCFCB units, is not developed.

Table 1. Key achievements against the strategic objectives of the CoE-OHS

Strategic objective	Achievements
To reduce occupational incidents and diseases (TB and pneumoconiosis)	• 264 active mining companies inspected; 80.29% inspected once, 71.9% visited at least twice • Supported formation of 12 ex-miners' co-operatives in nine districts; 240 ex-miners trained to run the cooperatives. • Decline in reportable incidents and fatal accidents in past 6 years: fatal accidents decreased from 22 (2015) to 14 (2022); reportable incidents decreased from 78 (2015) to 53 (2022)
To promote and undertake OHS research	• Supported regional baseline studies on OHS laws and workers' exposure to respirable crystalline silica dust • Supported local and regional project countries' development and revision of OHS laws, regulations, and guidelines • Supporting development of the regional occupational exposure limits guidelines, ASM OHS guidance, occupational health services frameworks, etc. • Conducted silicosis prevalence study • Supported mapping of miners and ex-miners in Zambia
To undertake timely evidence-based occupational medical surveillance and strengthen the compensation system	• Developed regional ILO ICRP curriculum and trained > 150 officials to harmonise medical surveillance approach • Developed regional code of practice on management of occupational lung diseases to strengthen evidence-based medical surveillance and compensation systems
To increase sub-regional capacity for the provision of OHS services	• Trained 150 local and international doctors on ILO ICRP • Engaged and collaborated with 11 internationally recognised ILO ICRP experts • Appointed and worked with the REAP from several countries and institutions, including ILO, to advise the CoE-OHS
To implement an integrated management system	• Conducted joint inspections and held NTC meetings where reporting was done to Permanent Secretaries responsible for health, mines, and labour • Implementing inclusive and integrated OHS programme that encompasses primary, secondary, and tertiary prevention interventions through different implementing agencies during joint inspections
To promote an exchange of knowledge and sharing of best practices	• Hosted experts from > 20 countries • Hosted Government of Malawi high-level delegations, comprising the Chair of the parliamentary committee on health, Directors of health, mines, and labour • Hosting and mentoring of students from local and international universities; 2 PhD students from Copperbelt University were attached and mentored • CoE-OHS chaired regional community of practice on occupational health and safety and mine regulations

ASM: artisanal and small mining, CoE: Centre of Excellence, ICRP: International Classification of Radiographs of Pneumoconioses, ILO: International Labour Organization, NTC: national technical committee, OHS: occupational health and safety, REAP: Regional Expert Advisory Panel

2. **Staffing:** The CoE faces inadequate staffing, exacerbated by the SATBHSS project's budget constraints, which only allowed for capacity building rather than hiring of new staff. The OHSI centres in Lusaka, Solwezi, and Kitwe urgently need more staff to improve efficiency.
3. **Equipment and Infrastructure:** Delays in acquiring and utilising specialised equipment, such as dust sampling machines and an XRD machine, have hindered the CoE's ability to provide specialised services. Ongoing civil works at the OHSI in Kitwe have affected service delivery and increased turnaround times for some tests.
4. **Funding and resource allocation:** Delays in fund disbursement, particularly in the final year, have affected the implementation of planned activities. Joint mining inspections are costly and require more trained inspectors and resources.
5. **Regulations and service provision:** There is a lack of regulations compelling non-mining sectors to conduct worker screenings. The current occupational health surveillance is not risk based, and there are gaps in impairment evaluation for compensation purposes. The temporary testing facilities are small and congested. Additionally, the OHSI needs to expand its research portfolio.
6. **Capacity building and coordination:** Limited funding for capacity building restricts the number and type of personnel that can be trained. There is a lack of clarity on stewardship and coordination of CoE institutions post-project. An accountability framework and clear communication strategy are also missing.
7. **Collaboration:** Collaboration with the Ministry of Health (MoH) is threatened since the OHSI is no longer an entity of the Ministry. The MoH is better suited for health service delivery due to its nationwide infrastructure and human resources, which are crucial for decentralising primary health care (PHC) and the District Health System (DHS) to enable effective screening, diagnosis, and treatment of occupational health diseases and injuries.
8. **Legal framework:** Zambia has a National Occupational Safety and Health (OSH) policy, but lacks the necessary OSH laws to support the CoE-OHS as a statutory body. The existing OSH laws and regulations are outdated and inadequate. Additionally, there is no resource mobilisation plan, and domestic funding commitments from stakeholders are inadequate. The CoE-OHS also lacks full-time administrative, coordination, and marketing professionals.

LESSONS LEARNED

Occupational safety and health spans all sectors, presenting opportunities for the MSD, OHSI, OSHSD, and WCFCB to collaborate, enhance efficiency, and reduce duplication of efforts.

The CoE has effectively fostered joint efforts to advance OHS in Zambia. By streamlining service delivery and increasing efficiency, the Consortium under the CoE has demonstrated its value. Decentralised services have expanded sector coverage.

Given that ex-miners are spread across the country, with the largest populations in the Luapula, Central, and Copperbelt provinces, there is a clear need to further decentralise services and enhance outreach efforts.

The CoE has huge potential to provide strategic support and human resource development in OHS for the entire southern African region. A coordinating board is essential for this purpose.

While the institutions within the CoE have always had the expertise, ability, and drive for OHS, the CoE has harnessed this potential to efficiently coordinate their activities. As the need for occupational health services is large, further expansion is required. The CoE institutions now have greater visibility and potential to attract resources, locally and externally.

The establishment of the regional CoE-OHS represents a unique and innovative initiative aimed at advancing OHS across Zambia and the continent. Equipped with state-of-the-art technology, the CoE-OHS is positioned to offer services and generate revenue, both domestically and regionally. However, it currently relies on government and partner funding for some activities.

Centralised procurement systems have significantly impacted the development and implementation of the CoE-OHS. Issues stem from insufficient technical knowledge among procurement specialists, and inadequate consultation during the acquisition of OHS infrastructure and equipment.

The CoE-OHS has been instrumental in garnering high-level political support, which led to the OHSI's integration into the MLSS, thus reducing function duplication. The CoE-OHS has also played a critical role in integrating primary, secondary, and tertiary OHS interventions, promoting evidence-based practices in the country. It has influenced the recognition of OHS as the Ministry of Labour's primary responsibility, in line with ILO conventions and recommendations.

The REAP is essential for ensuring the sustainability and quality of services and research, adhering to international best practices. However, the four CoE institutions do not have regular meetings, and cannot rely solely on the biannual REAP meetings.

RECOMMENDATIONS TO IMPROVE FUTURE IMPLEMENTATIONS OF THE CENTRE OF EXCELLENCE

1. There is potential for income generation to sustain CoE activities from the newly established centres in Solwezi and Lusaka, as well as at OHSI Kitwe. To maximise this potential, these centres need adequate human resources to scale up operations, reduce turnaround times for results, improve service efficiency, and enhance client satisfaction.
2. Planned renovations should be completed before the project's closure, and all procured equipment must be functional. The OHSI should focus on building local capacity for staff in equipment maintenance and calibration.
3. The CoE should establish a coordinating mechanism with a clear governance structure recognised by all four participating agencies. It is recommended that the OHSI be appointed as the lead technical agency and Chair of the implementation.
4. The OHSI should implement a risk-based medical surveillance system once risk profiles are developed. The MSD needs to urgently create risk profiles for all mining areas to support this approach. Additionally, the OHSI should conduct external occupational health audits to ensure service quality.
5. The CoE has drafted a strategic plan based on the concept note, which has been adopted by the relevant ministries and institutions. This plan still needs government endorsement before it can be rolled out for implementation.
6. The sustainability plan must also be adopted alongside the strategic plan. A statutory instrument, specifying user fees for various services, such as inspections, is needed.
7. The signing of a memorandum of understanding with Copperbelt University should be expedited to enhance human resource development.

8. The AUDA-NEPAD should continue supporting regional interventions for the CoE, to facilitate implementation and coordination. It should also help the CoE to refine the training curriculum in occupational health, in collaboration with local universities.
9. An internal consortium should be established to identify joint income generation activities, through research and training grants, in collaboration with local, regional, and international stakeholders.
10. The CoE should develop and display a client charter to help clients understand procedures and expected service processes. Front office staff and those interacting with clients should improve their customer relations skills.
11. Sub-technical working groups focused on resource mobilisation, research and development, and marketing should be created to enhance the sustainability of the CoE-OHS.

CONCLUSION

The evaluation revealed that the objectives of the CoE have been achieved. The CoE has been equipped to deliver essential and specialised occupational health services. Each consortium member has provided strategic and complementary services, contributing to the CoE's goals and objectives. To ensure the CoE's sustainability, it is crucial to complete the remaining infrastructure work and the strategic and sustainability plans. These plans will be fundamental in coordinating the CoE's interventions. We recommend that Zambia urgently finalises the development and adoption of these plans, and accelerates the completion of the infrastructure.

POLICY IMPLICATIONS OF FINDINGS

1. The absence of a coordinating mechanism for the CoE threatens the continuity of joint missions and efforts. It is, therefore, crucial to urgently establish the mechanism for coordinating the interventions under the CoE and post the project.
2. The project's duration should be extended to allow completion of the remaining infrastructure work and outstanding procurements that are essential for the CoE's sustainability, particularly given the significant capital investment in equipment such as the XRD.
3. The CoE should strengthen its connections with academic institutions to ensure ongoing human resource development, which is critical for the delivery of specialised services.

Achieving the Africa we want through the Second Ten-Year Implementation Plan of the African Union Agenda 2063

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As Africa transitions into the second decade of implementing Agenda 2063, the continent seizes this opportunity to collectively reflect on the lessons learned from the first decade and build a platform for renewed commitment. Agenda 2063, our continent's bold and transformative vision, was conceived to chart a course towards an integrated, prosperous, and peaceful Africa, driven by its own citizens playing a dynamic role on the global stage. This vision, articulated through the aspirations and dreams of African people, underscores our shared determination to harness our collective potential to realise *The Africa We Want*.

Our journey towards *The Africa We Want* began with the recognition of the need for a unified and strategic approach to tackle Africa's developmental challenges. The African Union (AU), reflecting on the successes and lessons from the decolonisation era spearheaded by the Organization of African Unity, identified the imperative for a new roadmap to galvanise the continent's socio-economic transformation.

Agenda 2063 was born from a collective desire to transform Africa's socio-economic landscape. It was conceived as a comprehensive blueprint that builds on past experiences, consolidates present achievements, and addresses current and future challenges. The Agenda seeks to promote inclusive growth, sustainable development, and regional integration. This visionary Agenda was developed through extensive consultations with stakeholders at national, regional, and continental levels, ensuring that it resonates with the aspirations of all Africans.

Agenda 2063, a 50-year development blueprint of the continent, is operationalised through five 10-year implementation plans. The structure of Agenda 2063 allows for periodic assessments, agility, and the incorporation of lessons learned into its implementation, thereby ensuring that the Agenda remains responsive and relevant to the changing dynamics of our continent and the global environment.

ACHIEVEMENTS OF FIRST TEN-YEAR IMPLEMENTATION PLAN

The First Ten-Year Implementation Plan (FTYIP), spanning 2014 to 2023, laid a robust foundation for Africa's transformation. During this period, significant progress was made across various sectors. Economic growth and integration saw the operationalisation of the African Continental Free Trade Area (AfCFTA), which fosters intra-African trade and economic collaboration. The continent also made some progress in infrastructure development, enhancing connectivity and regional integration.

In terms of social development, notable advances in education, health, and gender equality were registered. Initiatives aimed at enhancing access to quality education and healthcare services were implemented within continental development frameworks, contributing to improved human development indices across several African countries. Efforts to promote gender equality resulted in increased representation of women in political and economic spheres, empowering women and fostering more inclusive development.

Image: courtesy of the AUDA-NEPAD

Governance and peace initiatives were strengthened, leading to relative stability in many parts of the continent. Mechanisms for conflict prevention and resolution were bolstered, contributing to a more secure environment that is conducive to development. The deployment of peacekeeping missions and diplomatic efforts to mediate conflicts helped reduce violence and promote political stability. Additionally, anti-corruption measures and reforms in public administration improved governance and accountability, fostering trust between citizens and their governments.

The implementation of Agenda 2063 during the first decade also revealed several critical lessons. Ownership and inclusivity are essential for success. The inclusive approach in the design and implementation of the first 10-year plan fostered a sense of ownership among stakeholders. However, there is a need for deeper engagement and popularisation of Agenda 2063 – especially at national and sub-national levels – to ensure broad-based support and implementation. This includes raising awareness about the Agenda among citizens, local governments, and civil society organisations, and encouraging their active participation in the development process.

The period highlighted the necessity for building resilience into our development plans. The impact of global events, such as the COVID-19 pandemic, underscored the importance of adaptable and robust systems to mitigate external shocks. This involves investing in healthcare infrastructure, developing emergency response capabilities, and creating social safety nets to protect vulnerable populations during crises.

Effective implementation requires sustained, structured, and well-coordinated efforts, particularly in strengthening the capacities of AU Regional Economic Communities (RECs) and member states to mainstream and implement Agenda 2063, through national planning and budgeting processes. Strengthening institutional capacities, enhancing data collection and analysis, and promoting intergovernmental coordination are crucial for achieving Africa's development blueprint.

MOONSHOT AMBITIONS OF THE SECOND TEN-YEAR IMPLEMENTATION PLAN

As we transition into the Second Ten-Year Implementation Plan (STYIP), which spans 2024 to 2033, our focus has shifted towards accelerating and deepening the impacts of our efforts. The STYIP aims to build on the foundations laid by the FTYIP, addressing gaps and enhancing mechanisms to achieve greater outcomes.

To this end, we have identified seven Moonshots, inspired by the aspirations of Agenda 2063, to serve as rallying points for our efforts (see Figure 1). The Moonshots are ambitious but realistic transformative targets designed to catalyse significant and lasting change, addressing both immediate needs and long-term goals, thereby contributing to a more integrated, prosperous, and resilient Africa. The seven Moonshots are: 1) Every AU member state attains at least middle-income status; 2) Africa is more integrated and connected; 3) Public institutions are more responsive; 4) Africa resolves conflicts amicably; 5) African cultures and values are explicit and promoted; 6) African citizens are more empowered and more productive; and 7) Africa is a strong and influential global player.

Economic diversification and industrialisation will be key priorities. Currently, Africa's economies are heavily reliant on primary commodities, making them vulnerable to global price fluctuations. In 2023, the manufacturing sector contributed only 10% to Africa's gross domestic product (GDP). To achieve sustainable growth, we aim to increase this contribution to 20% by 2033. This involves supporting small and medium-sized enterprises (SMEs), promoting innovation and technology adoption, and creating favourable business environments to attract investment. Enhancing value addition in critical sectors such as agriculture, and addressing challenges such as reducing post-harvest losses that currently stand at 30% to a maximum of 10% by 2033, can significantly boost productivity and household incomes.

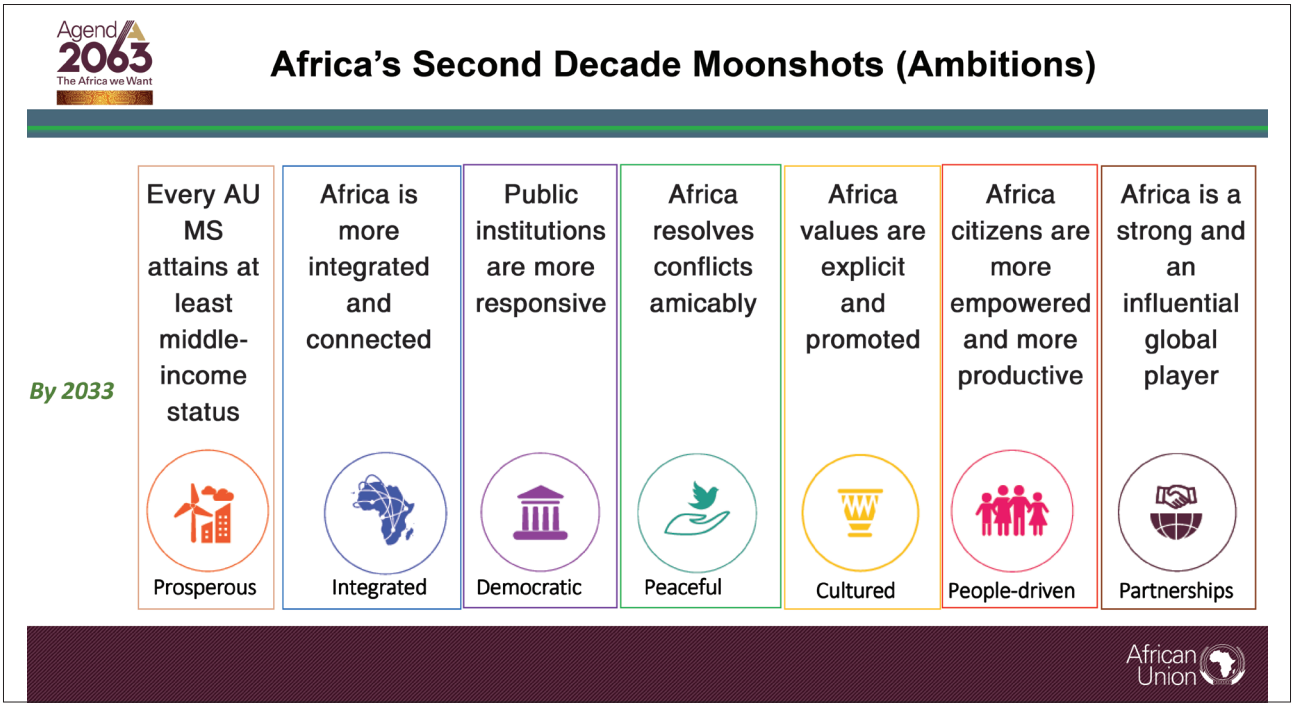

Figure 1. Agenda 2063 Moonshots for the Second Ten-Year Implementation Plan

AU: African Union, MS: member state

Image: courtesy of the AUDA-NEPAD

Investing in education, health, and skills development will continue to be a priority to empower our citizens, particularly the youth, to drive the continent's transformation. Currently, only 40% of African children complete secondary education. Our goal is to increase this to at least 80% by 2033. Expanding access to quality education, vocational training, and healthcare services will be essential for building a skilled and healthy workforce capable of contributing to sustainable development. Initiatives to promote science, technology, engineering, and mathematics (STEM) education will also be crucial for fostering innovation and technological advancement. Presently, STEM graduates make up 20% of all graduates; our target is to raise this to 40%.

Environmental sustainability and climate resilience will be integral to our development strategies, ensuring that progress is sustainable and inclusive. Africa accounts for less than 4% of global greenhouse gas emissions but suffers disproportionately from the impact of climate change. Efforts to promote renewable energy, conservation, and sustainable land management will be crucial for mitigating these impacts and preserving natural resources for future generations. Currently, renewable energy constitutes 10% of Africa's energy mix. By 2033, we aim to increase this to 40%. Implementing policies and programmes that support green growth, reduce carbon emissions, and enhance environmental protection will be essential for achieving long-term sustainability.

Strengthening peace and security frameworks remains crucial for fostering a stable environment for growth and development. Enhanced cooperation and capacity-building initiatives will be pivotal in this regard. The number of armed conflicts in Africa decreased significantly during the first decade of implementing Agenda 2063. Our goal is to eliminate all armed conflicts by 2033. This includes supporting conflict resolution and peacebuilding efforts, and ensuring that conflicts are resolved amicably, promoting good governance and the rule of law, and addressing the root causes of conflicts, such as poverty, inequality, and political instability.

As we embark on domesticating and implementing the second 10-year plan, we draw inspiration from our past achievements and lessons learned. It is crucial to renew our commitment to the values and principles of Agenda 2063. Achieving

Image: courtesy of the AUDA-NEPAD

the Moonshots and associated strategic objectives and targets outlined in the second 10-year plan requires collective and concerted efforts, and unwavering dedication. Furthermore, multi-stakeholder collaborations, underpinned by robust coordination mechanisms, will be a prerequisite for the successful implementation of Africa's development blueprint. This requires active engagement and participation of governments of member states and RECs, the private sector, civil society, development partners and, most importantly, the African people – including the diaspora. Our collective resolve, coupled with innovative approaches and strategic partnerships, will be instrumental in driving the continent towards the realisation of the Moonshots. Engaging the diaspora and leveraging their expertise, resources, and networks will also be crucial for supporting development efforts on the continent.

Together, with determination and unity, we will realise the aspirations of the African people. The journey continues, and with everyone's support, the future is bright for Africa.

Image: courtesy of the AUDA-NEPAD

Tuberculosis, HIV, and silicosis screening in an artisanal and small-scale alluvial gold mining community in Mwenezi district, Zimbabwe

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ABSTRACT

Artisanal and small-scale alluvial gold mining in Zimbabwe is a common economic activity in Mwenezi district. In most artisanal and small-scale mining areas, there is lack of access to occupational health services. A five-day mobile occupational health screening service was offered in Mwenezi district with the aim of providing health screening services to artisanal and small-scale alluvial gold miners (ASAGMs) and community members; 68 ASAGMs and 81 community members were screened for tuberculosis (TB). The ASAGMs were predominantly female (n = 38; 55.9%). Four cases of TB were diagnosed among the community members. No silicosis or TB cases were diagnosed among the ASAGMs. Eight (11.8%) ASAGMs were HIV-positive. Almost half (n = 15; 42%) of the screening audiometry tests showed impaired hearing. The local health staff reported that ASAGMs in the region lack access to occupational health services and were constrained by financial costs to travel for screening for occupational health diseases. Unlike in most artisanal and small-scale mining in Zimbabwe, which is male-dominated, Mwenezi district had more women who accessed the five-day mobile occupational health screening services. Providing mobile occupational health services in remote mining sites improves access to healthcare services for both women and men.

INTRODUCTION

There is a growing global concern regarding the health and safety of artisanal and small-scale miners (ASMs), particularly in relation to mercury exposure, injuries and accidents, tuberculosis (TB), and silicosis.[1-3] Artisanal and small-scale miners work in conditions that expose them to multiple health and safety hazards.[4] Globally, there are more than 45 million ASMs; more than 10 million are in Africa.[5-6] Artisanal and small-scale miners are a vulnerable group due to archaic mining methods, poor health and safety practices, and operation in remote and hard-to-reach areas, which are underserved by health services.

Women and girls involved in artisanal and small-scale gold mining are more vulnerable than their male counterparts, due to gendered differences in occupational health and safety (OHS) that include employment patterns, cultural beliefs, societal roles, expectations, responsibilities, and a male-dominated mining sector.[7] Gendered OHS issues in ASMs are multiple, significant, and often not comprehensively addressed. Women and men are differentially exposed to occupational hazards due to their anatomical and biological differences. Access to health services, including maternity services, is very limited for women due to both travel costs and long distances from the nearest health facility. The Ministry of Health and Childcare (MoHCC) in Zimbabwe, with support from the United States Agency for International Development (USAID), introduced a health screening programme under the Kunda Nqob'i TB (KNTB) Project for tuberculosis (TB), human immunodeficiency virus (HIV) and silicosis, specifically for ASMs. One of the key focus areas of the KNTB Project is women in artisanal and small-scale alluvial gold mining. Generally, artisanal and small-scale alluvial gold mining is male-dominated in Zimbabwe. Mwenezi district is unique in that more women than men are involved in alluvial gold mining. The aim of this report is to highlight the experiences and lessons learnt in providing outreach services for TB, HIV and silicosis screening targeted at women and men in artisanal and small-scale alluvial gold mining in Mwenezi district, Zimbabwe.

The aim of the occupational health outreach service was to provide health screening services for TB, HIV, occupational lung diseases (OLDs), and other health conditions.

METHODS

Baines Occupational Health Services (BOHS), one of the implementing partners of the KNTB Project, provided a five-day mobile occupational health outreach service at Lundi Clinic in Mwenezi district from 8 to 12 April 2024. Mwenezi district is located to the south of Masvingo province, Zimbabwe, and shares boundaries with Beitbridge in the south, Chivi in the north, Mberengwa in the west, and Chiredzi in the east. The district has a population of 209 327.[8] Artisanal and small-scale alluvial gold mining is one of the key economic activities in the district, which has 24 health facilities, with two TB diagnosing centres at

Neshuro District Hospital and Matibi Mission Hospital. These two hospitals are the only health facilities with onsite radiological services. Not all the health facilities in the district offer occupational health services.

A week prior to conducting the outreach activity, a two-day sensitisation and mobilisation service was carried out in the surrounding artisanal and small-scale alluvial gold mining areas in the Mwenezi district. This was conducted by representatives from the MoHCC district TB and leprosy programme office, a representative from the artisanal small-scale alluvial gold miners' (ASAGMs') leadership, Jointed Hands Welfare Organisation (JHWO), which is a community-based organisation, and two representatives from BOHS. The mobilising team played several roles that included i) informing the ASAGMs about the forthcoming health screening activity, and describing the process, benefits and key logistics for screening, ii) distributing posters and pamphlets about the event, (iii) establishing rapport with the ASAGMs, and (iv) assessing the road infrastructure and suitable camping sites for the mobile outreach service at Lundi Clinic, a public health facility.

The mobile outreach service consisted of a digital X-ray machine, audiometer, spirometer, basic medical equipment for assisting with clinical consultations, and a medical team comprising occupational health experts and a radiographer from BOHS, and health workers from Lundi Clinic. Health screening was voluntary.

The health service package included:

- Radiology services for screening for TB and OLDs
- An HIV voluntary counselling and testing centre
- Pure-tone air conduction audiometry
- Spirometry
- Health and safety talks on safe mining practices and fundamental information on TB and OLDs
- Physical examinations
- Sputum collection for Xpert *Mycobacterium tuberculosis* rifampicin resistance (Xpert MTB/RIF) testing

Health registers, including TB registers, TB preventive therapy registers, and health attendance registers from Lundi Clinic were used to capture routine demographic and clinical data according to the MoHCC guidelines. All diagnosed TB cases were recorded in the TB register at Lundi Clinic.

RESULTS

Over the five-day period, 149 ASAGMs and community members were screened for TB (Table 1). Of these, 81 (54.3%) were from the general mining community and 68 (45.6%) were ASAGMs. The ASAGMs were predominantly female (n = 39; 57.0%). None of the 68 ASAGMs who were screened for TB and the 60 who were screened for silicosis had either of the two diseases. Of the 49 ASAGMs with known HIV status, eight (16.0%) women were HIV-positive; all the men were HIV-negative. Four participants from the community were diagnosed with TB, one of whom had the TB bacteriologically confirmed (Xpert MTB/RIF positive). Two (6.0%) of the 50 spirometry tests were abnormal, showing a mild restrictive lung defect. Fifteen (42.9%) of the 35 screening audiometry tests done on the ASAGMs were abnormal and required further diagnostic audiometry.

The Mwenezi district TB coordinator, environmental health technician (EHT), local clinic nurse and ASAGMs shared key comments on the occupational health outreach service. The TB coordinator expressed strong support for the project and highlighted that it had improved access to TB and OLD screening, especially for women.

> *"The ability to conduct on-site TB, HIV and silicosis screenings has been a game-changer, enabling early detection and linkage to care for these vulnerable communities. By extending the radiology screening activity to additional sites, the project would be able to reach a larger proportion of the ASAGMs' population and have an even greater impact on addressing the significant burden of TB and silicosis in these communities."*

The EHT noted the importance of the outreach health screening service.

> *"With these new diagnoses, the local health team can now conduct aggressive contact tracing and follow-up to ensure prompt linkage to treatment and care for both the index cases and their close contacts. This proactive approach, facilitated by the radiology screening programme, is crucial for interrupting the chain*

Table 1. Tests conducted and findings in attendees of the health screening service (N = 149)

Test/finding	Attendees	Sex				All
		Male		Female		
		n	%	n	%	n
TB screening	ASAGMs and community members	DND	-	DND	-	81
TB diagnosed	community members	DND	-	DND	-	4
TB screening	ASAGMs	29	42.6	39	57.4	68
Presumed TB	ASAGMs	3	60.0	2		5
TB diagnosed	ASAGMs	0	-	0	-	0
Silicosis screening	ASAGMs	27	45.0	33		60
Silicosis diagnosed	ASAGMs	0	-	0	-	0
Eligible for TB preventive therapy	ASAGMs	0	-	0	-	0
Silico-TB diagnosed	ASAGMs	0	-	0	-	0
HIV tests conducted	ASAGMs	21	42.9	28	57.1	49
HIV diagnosed	ASAGMs	0	-	8	100.0	8
Spirometry tests	ASAGMs	26	52.0	24	48.0	50
Audiometry tests	ASAGMs	15	42.9	20	57.1	35

DND: data not disaggregated as the information was not captured on the data proforma
ASAGMs: artisanal and small-scale alluvial gold miners, HIV: human immunodeficiency virus, TB: tuberculosis

Figure 1. Women and girls involved in alluvial mining along the Runde River
Photograph: Blessings Chigaraza

of TB transmission and preventing the disease from spreading more widely throughout the ASAGMs' communities and beyond. By addressing these multiple health concerns simultaneously, the project is able to provide a comprehensive package of services that addresses the complex health needs of the ASM population."

The local clinic nurse expressed how the outreach facility had removed access barriers to TB and OLDs diagnosis.

"The free nature of the screening and treatment has been remarkable, removing the financial barriers that often prevent marginalised groups from seeking care. ASAGMs and their families have expressed deep relief and appreciation for the opportunity to undergo comprehensive screening and receive necessary treatment and follow-up care at no cost to them."

During the sensitisation and mobilisation activities, the team observed a number of occupational hazards at the worksites, including ergonomic hazards where women engaged in alluvial mining by the Runde River spent long hours standing in water – often in awkward positions – performing tasks that lead to repetitive musculoskeletal motions (Figure 1). Young women and girls were observed engaging in alluvial gold mining alongside older women.

DISCUSSION

Artisanal and small-scale mining in Mwenezi district is predominantly alluvial and mostly carried out by women along the Runde River. There were no recorded cases of TB or silicosis among the ASAGMs who were screened. There is a high burden of hearing impairment among artisanal miners in Mwenezi district. Women are exposed mainly to ergonomic hazards.

This report shows that, in Mwenezi district, women are more involved in alluvial mining than in other districts such as Kwe Kwe, Shurugwi, Gwanda, Insiza, and Zvishavane, where mining is predominantly underground and male miners far outnumber women. We found that women involved in alluvial mining have a lower burden of TB, HIV and OLD compared to ASAGMs working in underground mines.[3-4] The high level of hearing impairment amongst the miners in Mwenezi is similar to miners in a gold mining community in Nicaragua who had poor hearing.[9] Female ASAGMs in Mwenezi district are exposed to significant ergonomic hazards in similar ways to women engaged in artisanal gold mining in the Democratic Republic of Congo and Uganda.[6-7] Studies on ASAGMs in other districts in Zimbabwe have also noted that delivering occupational health services through a mobile outreach approach significantly removes barriers associated with access to healthcare services.[1,3]

CONCLUSION

Delivering occupational health services for TB, HIV and silicosis screening, and other tests through an outreach approach removes barriers of access to care for women in alluvial gold mining. Women in alluvial gold mining in Mwenezi district have a lower burden of TB, HIV and silicosis than their male counterparts in the districts of Shurugwi, Kwe Kwe and Gwanda, but there is an urgent need to address ergonomic hazards. More mobile occupational health outreach services should be provided in areas in which there is artisanal and small-scale alluvial gold mining.

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