TB, HIV and Silicosis in Miners

Epidemiological Data on Tuberculosis, Multi-Drug Resistant TB, Silicosis and HIV among Miners and Ex-Miners in Southern Africa

About this Report

The various mining industries contribute significantly to the Southern African region economy and to the world mineral resources. Yet health and safety concerns in the mining industry continue to compromise miners and their communities' wellbeing. TB in the Mining Sector in Southern Africa (TIMS) is a programme that was initiated to create a regionally coordinated response to TB and related illnesses affecting mineworkers, ex-mineworkers, their families and communities in Southern Africa. The Southern African Development Community (SADC), through the SADC Declaration, provided the statutory commitment to the programme and galvanised the Global Fund to support a regional TB response in the mining sector. The programme will be implemented in Botswana, Lesotho, Namibia, Malawi, Mozambique, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. This report will inform the strategic placement and delivery of relevant health and support services, including occupational health facilities in the region and provides data that can be used to inform programme baseline indicators.

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Perinatal HIV Research Unit of the University of the Witwatersrand

Principal Investigator

Dr Limakatso Lebina
Perinatal HIV Research Unit
University of the Witwatersrand
Johannesburg, South Africa

Co-Investigators

Dr Neil Martinson
Perinatal HIV Research Unit
University of the Witwatersrand
Johannesburg, South Africa

Ms Minja Milovanovic
Perinatal HIV Research Unit
University of the Witwatersrand
Johannesburg, South Africa

Dr Anthony Kinghorn
Perinatal HIV Research Unit
University of the Witwatersrand
Johannesburg, South Africa

Investigators

Ms Nancy Coulson
Centre for Sustainability in Mining and Industry
University of the Witwatersrand
Johannesburg, South Africa

Dr Daniel Limpitlaw
Centre for Sustainability in Mining and Industry
University of the Witwatersrand
Johannesburg, South Africa

Dr Gill Nelson
Division of Occupational Health,
School of Public Health,
University of the Witwatersrand
Johannesburg, South Africa

Dr Ebrahim Variava
Klerksdorp/Tshepong Hospital Complex
Klerksdorp
North West, South Africa

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Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
ART	Antiretroviral Therapy
ARVs	Antiretrovirals
ASM	Artisanal and Small-Scale Mining
CCOD	Compensation Commissioner of Occupational Disease
DHS	Demographic and Health Surveys
CSMI	Centre for Sustainability in Mining and Industry
DMR	Department of Mineral Resources
DoH	Department of Health
DPME	Department Planning, Monitoring and Evaluation
GDP	Gross Domestic Product
GRI	Global Reporting Initiative
HIV	Human Immunodeficiency Virus
ILO	International Labour Organization
IQR	Interquartile Range
MBOD	Medical Bureau for Occupational Disease
MDG	Millenium Deveopment Goals
MDR	Multi-Drug Resistant
MHSA	Mine Health and Safety Act (No. 29 of 1996)
MMSD	Mining, Minerals and Sustainable Development (Southern Africa report)
MOSH	Mining Occupational Health Safety
NGO	Non-Governmental Organisation
NTCP	National Tuberculosis Program
ODMWA	Occupational Diseases in Mines and Works Act (No. 78 of 1973 as amended)
OHS	Occupational Health Services
PHRU	Perinatal HIV Research Unit
PT	Preventive Treatment
RPF	Request per Proposal
TB	Tuberculosis
TIMS	TB in the Mining Sector in Southern Africa
SADC	Southern African Development Community
MDG	Millennium Development Goals
MMC	Medical Male Circumcision
MMSD	Mining, Minerals and Sustainable Development (Southern Africa report)
UNAIDS	Joint United Nations Programme on HIV/AIDS
USAID	United States Agency for International Development
PMTCT	Prevention of Mother to Child Transmission
VVMC	Voluntary Medical Male Circumcision
WHO	World Health Organization

Glossary of Terms

Acquired Immune Deficiency Syndrome:
A disease of the immune system due to infection with HIV. HIV destroys the CD4 T lymphocytes (CD4 cells) of the immune system, leaving the body vulnerable to life-threatening infections and cancers. Acquired immunodeficiency syndrome (AIDS) is the most advanced stage of HIV infection. To be diagnosed with AIDS, a person with HIV must have an AIDS-defining condition or have a CD4 count less than 200 cells/mm^3 (regardless of whether the person has an AIDS-defining condition).

Antiretroviral Therapy:
The daily use of a combination of HIV medicines (called an HIV regimen) to treat HIV infection. A person's initial HIV regimen generally includes three antiretroviral (ARV) drugs from at least two different HIV drug classes.

Antiretroviral:
A drug used to prevent a retrovirus, such as HIV, from replicating. The term primarily refers to antiretroviral (ARV) HIV drugs.

Artisanal and Small-Scale Mining:
Artisanal and Small-scale mining (ASM) refers to informal mining activities carried out using low technology or with minimal machinery. It is estimated that more than 100 million people rely on this sector for income, mainly in developing nations. In some areas ASM takes place alongside large-scale formal mining leading to conflicts.

Compensation Fund:
Workers' compensation is a form of insurance providing wage replacement and medical benefits to employees injured in the course of employment in exchange for mandatory relinquishment of the employee's right to sue his or her employer for the tort of negligence.

Commodity:
A raw material or primary agricultural product that can be bought and sold.

Gross Domestic Product:
The total value of goods produced and services provided in a country during one year.

Human Immunodeficiency Virus:
The virus that causes AIDS, which is the most advanced stage of HIV infection. HIV is a retrovirus that occurs as two types: HIV-1 and HIV-2. Both types are transmitted through direct contact with HIV-infected body fluids, such as blood, semen, and genital secretions, or from an HIV-infected mother to her child during pregnancy, birth, or breastfeeding (through breast milk).

Multiple Drug Resistant TB:
A form of tuberculosis (TB) that is resistant to at least the two most effective antibiotics commonly used to cure TB infection (isoniazid and rifampicin). People infected with multiple drug resistant-TB (MDR-TB) are at high risk for treatment failure. They are also at risk for further drug resistance, which can lead to life-threatening disease—extensively drug resistant tuberculosis (XDR-TB).

Tuberculosis:
An infection caused by the bacteria Mycobacterium tuberculosis and Mycobacterium bovis. Tuberculosis (TB) is spread when a person with an active infection (TB disease) coughs, sneezes, speaks, or sings, and then a person nearby breathes in the bacteria. TB

usually affects the lungs, but it can also affect other parts of the body, such as the kidneys, spine, and brain. There are two forms of TB: latent TB infection and TB disease. In people with HIV, TB is considered an AIDS-defining condition.

Mycobacterium tuberculosis:

Tuberculosis (TB) is an infectious disease caused by the bacterium Mycobacterium tuberculosis (MTB). Tuberculosis generally affects the lungs, but can also affect other parts of the body.

Medical Male Circumcision:

Male circumcision is surgical removal of the foreskin - the retractable fold of tissue that covers the head of the penis. The inner aspect of the foreskin is highly susceptible to HIV infections. Trained health professionals can safely remove the foreskin of infants, adolescents and adults

Prevention of Mother to Child Transmission of HIV:

Mother-to-child transmission of HIV is the spread of HIV from an HIV-infected woman to her child during pregnancy, childbirth (also called labour and delivery), or breastfeeding (through breast milk).

Seroprevalence:

Seroprevalence is the number of persons in a population who test positive for a specific disease based on serology (blood serum) specimens; often presented as a percent of the total specimens tested or as a proportion per 100,000 persons tested.

Systematic literature review:

A systematic review is a type of literature review that collects and critically analyses multiple research studies or papers.

Silicosis:

Silicosis is a progressive disease that belongs to a group of lung disorders called pneumoconiosis. Silicosis is marked by the formation of lumps (nodules) and fibrous scar tissue in the lungs. It is the oldest known occupational lung disease, and is caused by exposure to inhaled particles of silica, mostly from quartz in rocks, sand, and similar substances.

HIV seronegative:

A negative result in a test of blood serum for HIV.

Pneumoconiosis:

Any chronic lung disease caused by inhaling particles of silica or similar substances that lead to loss of lung function.

HIV prevalence rate:

HIV prevalence rate in selected populations refers to the percentage of people tested in each group who were found to be infected with HIV.

Xpert MTB/RIF test:

The Xpert MTB/RIF is a cartridge based nucleic acid amplification test, automated diagnostic test that can identify Mycobacterium tuberculosis (MTB) DNA and resistance to rifampicin (RIF) by nucleic acid amplification test (NAAT).

Figures and Tables

Figures

Tables

"The strength of the team is each individual member. The strength of each member is the team."

- Phil Jackson

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CENTRE FOR SUSTAINABILITY IN MINING AND INDUSTRY
UNIVERSITY OF THE WITWATERSRAND

WITS School of Public Health

TIMS TB in the Mining Sector Southern Africa

"If TB and HIV are a snake in Southern Africa, the head of the snake is here in South Africa. People come from all over the Southern African Development Community to work in our mines and they export TB and HIV, along with their earnings. If we want to kill a snake, we need to hit it on its head."

Dr Aaron Motsoaledi
South African Minister of Health
June 2010

Executive Summary

Background

Mining contributes significantly to the southern African region and the global economy. Yet health and safety concerns in the mining industry continue to compromise miners and their communities' wellbeing. The World Bank estimates that US$886-million is lost annually in the southern African region due to healthcare costs which include losing existing workers, decreased productivity and the expense of training new personnel.

Tuberculosis (TB) remains one of the world's greatest health threats, and the African region has the highest burden relative to population. Sub-Sahara Africa is the epi-centre for the HIV and AIDS epidemic. Miners, particularly deep-level gold miners, are at extreme risk of TB because of HIV infection and silicosis, exacerbated by working conditions and living environments – creating a "triple disease burden". TB is the leading cause of mortality in HIV-infected miners. The mining industry increases the risk of miners contracting HIV and TB and also sharply increases the risk of TB spreading in the community. Migration to and from different regions and across country borders disrupts the continuum of care for miners receiving treatment, jeopardizing their health and that of their families. Exposure to silica dust, which is highest in gold mining and quarrying industries, causes silicosis, an incurable lung disease, and also impairs the ability of the immune system to control TB infection and prevent TB disease.

This report aims to provide collated secondary epidemiological data describing the current TB, MDR-TB, HIV and silicosis in mineworkers and their communities in the 10 countries: Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. This report also aims to provide country specific data that indicates hotspots for TB in mineworkers, and proposals for setting baseline targets and location of the occupational health services (OHS).

Methods

A systematic secondary data review of published English language literature for the 10 countries was conducted by a multi-disciplinary team, including medical doctors, epidemiologists, and researchers. In addition, unpublished sources and citations in the published literature were reviewed for inclusion into the collated data. Following the systematic literature review, a list of key informants per country was developed and they were interviewed. The objective of interviewing these key informants was to gather additional information, data and reports that were not accessed during the literature search. Descriptive statistics, frequencies, medians and proportions were used to summarise the data at country and district level on TB, HIV and silicosis. Furthermore, graphs and tables were developed to visually display the data. Where no data was available for miners, adjusted district or country-level estimates were used as proxy.

Main findings

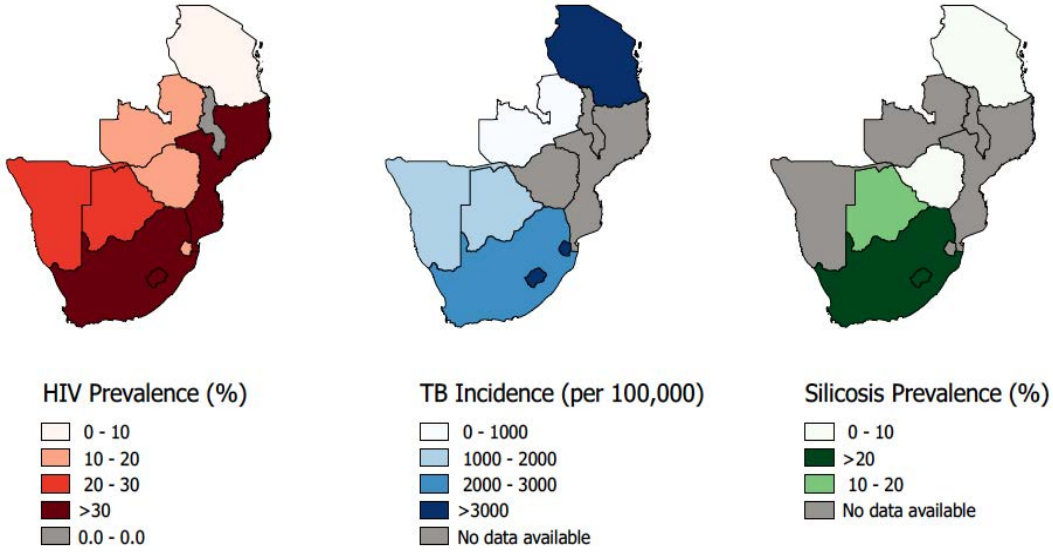
We found 950 publications describing TB, HIV and silicosis disease in mineworkers and their communities in the 10 countries under review, of which 449 (47%) were studies in South African miners followed by Tanzania, Malawi and Lesotho with 71 (7%); 58(6%) and 46 (5%) publications and reports respectively. Namibia had the least (7; 0,7%) publications on TB, HIV and silicosis. Data is scarce, not recent, and does not often describe country level TB and HIV prevalence in miners, ex-miners and labour sending areas. Moreover, HIV and TB data are not reported in "artisanal" miners who are largely ignored but, in some countries, make up the vast majority of miners.

Our best estimates are that in the general population HIV (amongst 15-49 years old) and TB (incidence per 100000) varies from a high of 29% and 852 to a low of 5% and 227 respectively. In miners HIV prevalence and TB prevalence vary from 47%; 7200 and 9%; 700 respectively (Figure A). TB incidence varies, with Lesotho having the highest at (852/100 000), followed by South Africa (834/100 000) and Swaziland (733/100 000). Nevertheless 4/10 of these countries are classified as high TB burden countries. All the countries are classified as high TB/HIV burden countries. Malawi has the lowest TB incidence of 227/100 000. The proportion of TB patients diagnosed with MDR-TB has increased in many southern African countries and ranges from 0,3% (Zambia) to 7,7% (Swaziland). As with many countries in Sub-Saharan Africa, these countries also have high HIV prevalence. Among 15-49 year olds, HIV prevalence

ranges from 4,7% (Tanzania) to 29% (Swaziland). Many TB patients are also co-infected with HIV (35%-79%).

South Africa, Mozambique and Zimbabwe have the largest geographical areas with multiple mining operations, mining different minerals and contributing 2,1% – 3,5% to the countries' GDPs. Mining in Malawi, Lesotho and Swaziland is under-developed, though there are plans for expansion. Most of the countries focus on mining commodities that are easily marketable and do not require much capital investment. The most mined minerals are: gold, copper, diamonds, platinum, coal and tanzanite. South Africa has the largest formal mining sector, with an estimated half a million employees currently. However, Tanzania is estimated to have around 1,5-million miners, most of whom work in the artisanal or small-scale mining sectors. The contribution of mining to GDP is substantial in many of the countries with Botswana having the highest percentage at 24,5%, and Swaziland the lowest at 2%.

In most of the reports reviewed, miners were found to have higher TB and HIV disease compared to the general population. In most countries, TB prevalence was twice as high for miners compared to the general population, while in some countries it was 6-8 times higher. In Mozambique, HIV prevalence in miners ranges from 26% to 42% compared to 11,6% among 15-49 year olds in the general population (TableA). Similarly, in Tanzania, HIV prevalence is 9% among miners compared to 4,7% in the general population. , ilicosis prevalence in miners is available in five countries and ranges from 0,1% in Zimbabwe to 32% in South Africa. Epidemiological literature on HIV, TB and silicosis is not available for most of the countries. The countries with the least available data on the epidemiology of HIV, TB and silicosis among miners are Malawi and Mozambique, and epidemiological surveys are recommended. Namibia, Swaziland, Zambia and Zimbabwe also have data gaps that need further research.



■ **Figure A Estimated HIV, TB and silicosis disease burden in mine workers in the ten SADC TIMS countries**

Country specific summaries on TB HIV and Silicosis disease burdens

Botswana: The mining industry contributes 25 percent to GDP and employs 3% of the total employed. The country HIV prevalence is estimated at 18,5%, but it is higher (24%) amongst mineworkers. The national TB incidence is 385 per 100000, and some of the mining districts TB incidence rates (438-520) are higher than the national average. Proportion of TB cases with MDR-TB is 2,5%. Pneumoconiosis prevalence in ex-miners is 10%. There is no data specific to mineworkers on TB. Priority areas for Occupational Health Services (OHS) are the Central and Eastern districts where most miners reside and TB and HIV prevalence is high.

Lesotho: Many Basotho men are employed in the mining industry in South Africa, with a few working in mines located in Lesotho. Since the decline in the mining industry in South Africa many have been retrenched. Most of the mineworkers (ex and current) reside in Berea, Leribe, Maseru, Mafeteng and Mohale's Hoek. The national TB incidence is 852 per 100000, with an overall HIV prevalence of 23% in the 15-49years age category. TB and HIV diseases burden are highest in Berea and Maseru, but the highest number of TB cases in miners and ex-miners were diagnosed in Mafeteng. Studies in mineworkers have shown that miners have a higher HIV prevalence than the general population (14% vs 10,6% in Butha-Buthe). Silicosis prevalence in ex-mine workers was 26%. Recommended districts for OHS are Maseru, Leribe and Mafeteng for current and ex-miners that worked in South African mines. Most miners in Lesotho mines are based in Butha-Buthe, Mokhlotlong and Berea although the numbers are small, they do not have access to occupational health services.

Malawi: The mining industry in Malawi contributes 2,3% to the GPD, with an estimated 54 000 people working in this industry, and there are plans for expansion. Most of the mines are located in the northern region. Unlike previously, there are very few current and ex-miners working in South African mines. The national TB incidence is 227 per 100000, and the northern region has the lowest number of TB cases reported based on the reports reviewed. HIV prevalence is lower (4-7% vs 9,1%) in mineworkers compared to the general population. There is no data on silicosis and TB amongst mineworkers. Primary studies on TB, HIV and silicosis prevalence in mineworkers should be considered in Malawi. OHS that target mineworkers would reach most of the miners if they are placed in the northern region.

Mozambique: Many Mozambican men have historically been employed and are currently being employed in South African mines. Mining contributes3,5% to GDP of Mozambique. The national HIV prevalence is 10,5% amongst people aged 15-49 years, and TB incidence rate is 554 per 100000. In a few studies, HIV prevalence in Mozambican men employed in South African mines was reported as 15 - 42%. There is no data specific to mineworkers from Mozambique on TB disease. The districts with the most mineworkers are Xai-Xai, Chibuto, city of Maputo and Manakazi, and these are the districts that should be prioritised for OHS but more data is needed on the TB disease burden in mineworkers.

Namibia: Diamonds are the most mined commodity in Namibia. The mining industry contributes 11,5% to GDP and employs 2% of the labour force, but only 17,3% of these people working in formal mining sector and the others in artisanal mining and quarrying. The national TB incidence is 627 per 100000, and the mining regions also have higher (1000 – 1380) TB incidence. The population HIV prevalence is 16%, however it is higher (20-25%) in the labour sending areas (Caprivi) and in some mining areas (Kavango and Erongo). There is no data specifically on mineworkers on TB, HIV and silicosis. Primary studies in these fields could fill some of the data gaps. The districts recommended for OHS are Caprivi (labour sending area) and Khomas, Kavango and Erongo.

South Africa: The mining industry in South Africa is one of largest in the world with about half a million current employees in the formal mining sector albeit reducing in size, with large numbers of retrenchments in recent years. Several studies have been documented on TB, HIV and silicosis in mineworkers. HIV and silicosis contribute to higher rates (1200 - 3000 per 100000) of TB among mineworkers compared to the national TB incidence of 834 per 100000. HIV prevalence is also higher (24%) amongst mineworkers compared to national adult average of 19,2%. The provinces that should be prioritized for OHS for mineworkers are Eastern Cape (labour sending area), North West and Gauteng Provinces

Swaziland: Most Swazi miners are employees in South African mines, with few mining companies in Swaziland. The national TB incidence rate is 733 per 100000, and

studies have reported TB prevalence of about 5000 per 100 000 in mineworkers. Similarly, the HIV prevalence is high (20%) in mineworkers, which is lower than the 29% national adult HIV prevalence. There is no data on silicosis in miners or ex-miners from Swaziland. The districts recommended for OHS are Hhohho and Shiselweni as they have higher numbers of mineworkers as well as extreme rates of TB and HIV disease prevalence.

Tanzania: The mining industry contributes 2,5% to the country's GDP with most mineworkers (over a million) being in the artisanal and small-scale mining (ASM) and few (15 000) employed in large-scale mining. The national TB incidence rate is 327 per 100000. Adult HIV prevalence in ASM miners has been estimated at 8,9% which is higher than the national average of 4,5%. Adult HIV prevalence has been found to be even higher (16-18%) in peri-mining communities. Silica dust exposure in some mining has been reported to exceed industry recommended limits, with a silicosis prevalence of 1,6% in mineworkers. Areas where most miners reside, that may also be appropriate areas for OHS are in the Geita region, Mererani town and Kishapu district.

Zambia: Mining industry is predominantly in the Copperbelt and the Lusaka provinces but has expanded rapidly in North West. Mining contributes 13,4% to the country's GDP. Zambia is the largest producer of copper and cobalt in Africa. The national TB incidence is relatively low at 406 per 10 0000, and the notification rates is highest in Lusaka and Copperbelt provinces. In the mining districts like Ndola, Kitwe and Solwezi TB prevalence is estimated at 600 - 2 294 per 100 000 but has been on a decline in both miners and the general population over the past ten years. The overall HIV prevalence is 12,7%, whereas amongst mineworkers and mining districts its 7-18%. Silicosis prevalence amongst copper mineworkers has been found to be 22,7%. OHS are recommended for Copperbelt and Lusaka Provinces.

Zimbabwe: The mining industry in Zimbabwe contributes 10,3% to the country's GDP , and is located along the Great Dyke area, which spans 550km and multiple provinces and districts and. Artisanal and small-scale mining is growing, employing 300 to 400 thousands miners. The national TB incidence is 603 per 100000, and there was no available data on TB incidence in mineworkers or mining districts. The HIV prevalence amongst adults is 15,2%, and Matabeleland and Bulawayo have the highest HIV prevalence. Pneumoconiosis prevalence in mineworkers is 0,1%. Bulawayo, Gweru and Bindura should be considered as possible priorities for OHS.

Artisanal and small-scale mining

Artisanal and small-scale mining (ASM) is in poorer communities and mostly done by people with minimal education and few employment opportunities. The operations are often unlicensed, mobile and flexible. There is no data that describes these population and their disease burden. However, in some of the countries, the majority of mineworkers are part of this sector, and the numbers are growing and will continue to increase. The greatest health challenges of ASM mineworkers are exposure to harmful chemicals, gases, noise and dust during mining procedures; no appropriate protective gear and limited access to healthcare services. Alcohol and drug abuse are reported to be common in the ASM sector, along with risky sexual behaviour, violence and criminal activities. Legislations on ASM vary per country with some countries regarding ASM as illegal. Provision of OHS will need to consider the ASM sector as they are the majority in some countries (Tanzania and Zimbabwe) and have minimal access to any special healthcare services unlike miners in large scale mining companies.

Limitations

There is paucity of published literature on mineworkers' health status, especially on HIV, TB and silicosis. There were also challenges in accessing unpublished data from some of the Departments or Ministries of Health. Mapping of mineworkers was therefore not able to be completed for all the 10 countries. Although data on TB and HIV is collected and updated in many countries, there are huge data gaps on HIV and TB for mineworkers as they have not been regarded as a separate high risk group. Many countries are also not measuring the prevalence of silicosis in mineworkers and some do not have in country capacity to diagnose silicosis. There is limited information on how labour migration patterns affect prevalence and care and risks of transmission to mineworker contacts. Absence of ethics approval for the key informants interviews in some of the countries prevented access to unpublished reports and any other additional information. Furthermore, language and format of reports is not standardised.

Recommendations

Mineworkers and their communities should be regarded as a high risk group for HIV and TB, which have particular needs. The evidence suggest that TB should be considered as an occupational disease in all countries. The following main recommendations arise from this epidemiological assessment in relation to regulation and system development to generate better routine and study data, and appropriate use of such data.

- Update routine data collection tools such as TB registers to include occupation and or mining exposure as a variable.
- Standardize terms such as: at risk mineworkers, quarries, silicosis and pneumoconiosis. This would also help to produce comparable data within and across countries.
- Consider which different models of Occupational Health Services responses are likely to be most efficient in serving the diverse contexts and needs of current, ex-miners, migrant mineworkers and artisanal mine workers.
- Consider specific OHS strategies for the ASM sector as it constitutes the majority of mineworkers in some countries.
- Plan and implement OHS in collaboration with Departments and Ministries of Health. Available epidemiological data has been used to identify possible priority areas for OHS, however for efficient and sustainable use of scarce health resources, further assessment of data, existing health services and appropriate models of intervention is desirable. This can improve targeting, as well as decisions of whether to use vertical or integrated models and static or mobile OHS.
- The initiatives of providing special health services should be extended to other African countries like the Democratic Republic of Congo and Angola where mining industry is developing.
- Primary epidemiological research in areas where there is limited secondary data on TB, HIV and silicosis in mineworkers and their communities like Malawi, Namibia, Mozambique and Zimbabwe.

■ **Table A:** Summary of TB, HIV and Silicosis in Miners and their communities in Southern Africa

		Botswana	Lesotho	Malawi	Mozambique
Country Statistics	**Population Size**	2 375 314	2 100 000	17 000 000	27 978 000
	Incidence of TB per 100 000 (Confidence Interval)	385 (361–410)	852 (612–1 130)	227 (122–365)	551 (435–680)
	Proportion of estimated drug- resistant TB (%)	2,5%	3,2%	0,42%	3,5%
	HIV Prevalence in those aged 15-49 year	18,5%	23%	9,1%	11,6%
	% of TB patients who are HIV infected	60%	72%	54%	52%
Mining Industry Statistics	**Most mined commodities**	Diamonds, Copper, Coal	Diamonds, Sandstone and Aggregate	Heavy minerals, Coal, Uranium, Lime stone	Bauxite, Gold, Graphite
	Mining Regions or Districts	Selebi-Phikwe, Sowa, Jwaneng	Butha Buthe, Berea, Maseru and Mokhotlong	Mzimba, Chitipa, Karonga, Rumphi	Mandla Kozo, Manjacze, Chibuto, Xai Xai, Cidade de Matolo, Maputo
	Size of mining population* **	29 043	15 911	54 000	174 906
	% of country GDP from mining	24,5%	7,9%	2,3%	3,5%
	Prevalence of TB in miners or mining area (per 100 000)	1 320	7 200	UNKNOWN	UNKNOWN
	HIV Prevalence in miners or mining area (%)	25%-28%	20%-40%	UNKNOWN	26%-42%
	Silicosis Prevalence (%)	10,2%	25%-26%	UNKNOWN	UNKNOWN
	Proposed Occupational Health Services (OHS) areas	Central and Eastern Districts	Maseru, Leribe and Mafeteng	Northern Region	Xai-Xai, Chibuto, city of Maputo, Manakazi

Namibia	South Africa	Swaziland	Tanzania	Zambia	Zimbabwe
2 400 000	54 956 900	1 300 000	54 308 045	16 000 000	15 000 000
561 (492–635)	834 (737–936)	733 (533–963)	327 (155–561)	406 (279–557)	278 (193–379)
3,8%	2,1%	7,7%	1,1%	0,3%	2,2%
13,3%	19,2%	28,8%	4,7%	12,9%	15%
44%	61%	79%	35%	73%	68%
Uranium, Copper, Zinc, Diamonds, , Gold	Gold, Coal, Iron, Platinum, Diamonds,	Coal, Asbestos, Diamonds	Gold, Copper, Silver, Cobalt, Tanzanite, Diamonds	Copper, Cobalt, Selenium, Gold, Iron, Emeralds	Gold, Diamond, Platinum,
Khomas, Erongo, Hardop, Karas, Otjozundjupa, Oshikoto	North West, Gauteng, Free state, Mpumalanga and Limpopo Provinces	Hhohho, Shiselweni, Limbombo	Mererani, Shishanga, Geita, Manyara, Arusha	Copper Belt, North-West Provinces and Kabwe	Midlands, Gweru, Bulawayo, Harare, Bindura
19 000	493 921	2 520	1 500 000	68 473	632 025
11,5%	4,9-8,3%	2%	3,6%	13,4%	10,3%
859-1 380	3 000	5 194	6 600	700-840	UNKNOWN
13%-24%	12%-47%	20%	9%	7%-18%	16%-20%
UNKNOWN	22%-32%	UNKNOWN	1,6%	UNKNOWN	0,1%
Caprivi, Khomas, Kavango and Erongo	Eastern Cape, North West and Gauteng Provinces	Hhohho and Shiselweni	Geita, Mererani town and Kishapu district	Copperbelt and Lusaka Provinces	Bulawayo, Gweru and Bindura

"The SADC mining sector is diverse and ranges from ultra-deep-level, narrow tabular gold mines in South Africa to open-pit diamond mines in Botswana. The range of commodities is vast as is the range of scales of exploitation, from the industrialised complexes of the Zambian Copperbelt to the artisanal pits in Tanzania."

Chapter 1: **Introduction**

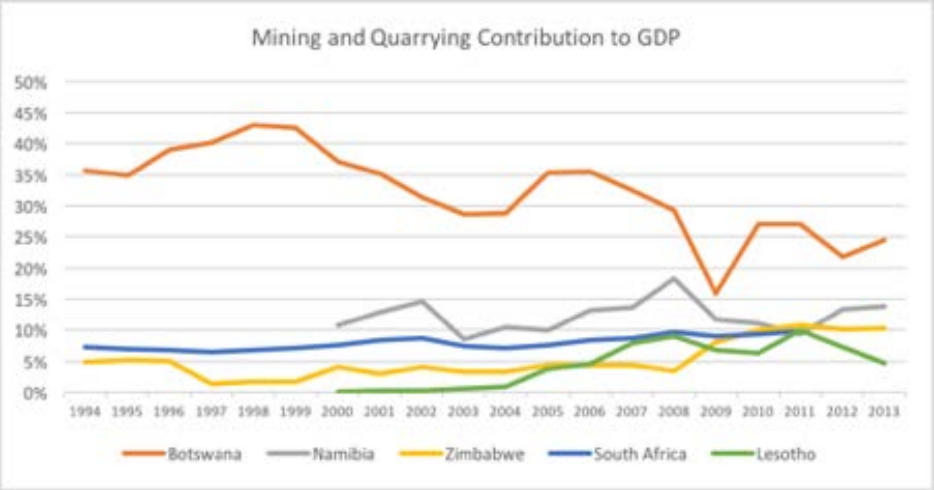
Mining landscape: Overview of mining in the Southern African Development Community

All SADC countries are dependant to some extent on the extraction of minerals, some more than others (this review excludes oil and gas, and does not cover the island states, Angola and the DRC).

Based on official SADC data[1], which is incomplete, with the most recent data points either 2011 or 2013, depending on the country, Botswana is the most dependant with nearly one quarter of GDP generated by mining and quarrying. Historically, this sector has contributed more than one third.

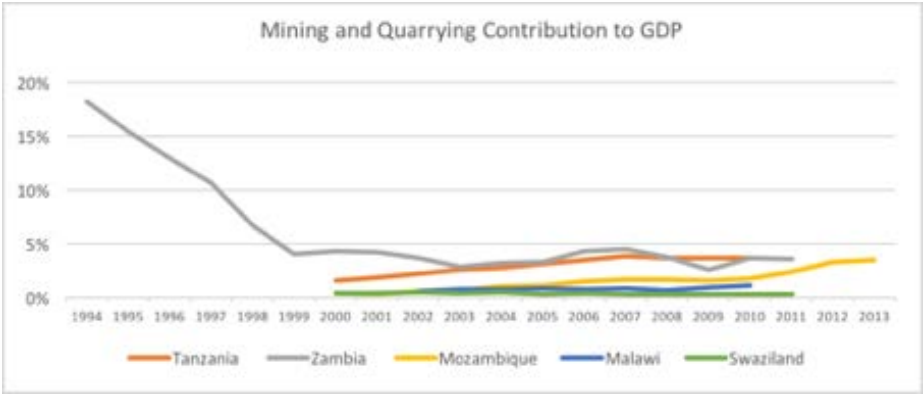
Other countries where mining and quarrying make significant contributions to GDP include Namibia, Zimbabwe, South Africa and Lesotho (see Figure 1.1).

Figure 1.1
SADC countries where the contribution of mining and quarrying to GDP is significant
Data: SADC



In a second grouping of countries mining and quarrying matters less. This group unexpectedly includes Zambia, the foremost copper producer on the continent and historically a mining power house, because of a precipitous decline in Zambian copper production at the turn of the century. The other countries in this second group are Tanzania, Mozambique, Malawi and Swaziland (see Figure 1.2).

Figure 1.2
SADC countries where the contribution of mining and quarrying to GDP is less significant
Data: SADC



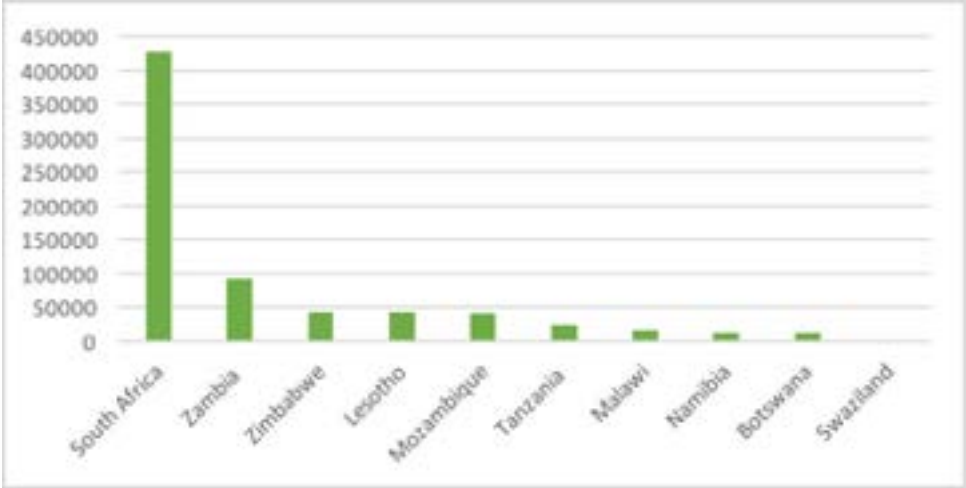
The SADC mining sector is diverse and ranges from ultra-deep-level, narrow tabular gold mines in South Africa to open-pit diamond mines in Botswana. The range of commodities is vast as is the range of scales of exploitation, from the industrialised complexes of the Zambian Copperbelt to the artisanal pits in Tanzania. In absolute terms, the mining and quarrying labour force in South Africa dwarfs the other countries in the region and, at 427 000, is around five times larger than the next largest country (Zambia: 92 810) (see Figure 1.3). Zimbabwe, Lesotho and Mozambique have similar numbers employed (although the number for Lesotho may include those employed outside of the country). The data sets range in age from 2003 to 2014 and are not strictly comparable (see individual country sections below for references).

Formal Employment

■ Figure 1.3

Absolute employment in the mining and quarrying sector in selected SADC countries

See individual country sections for data sources

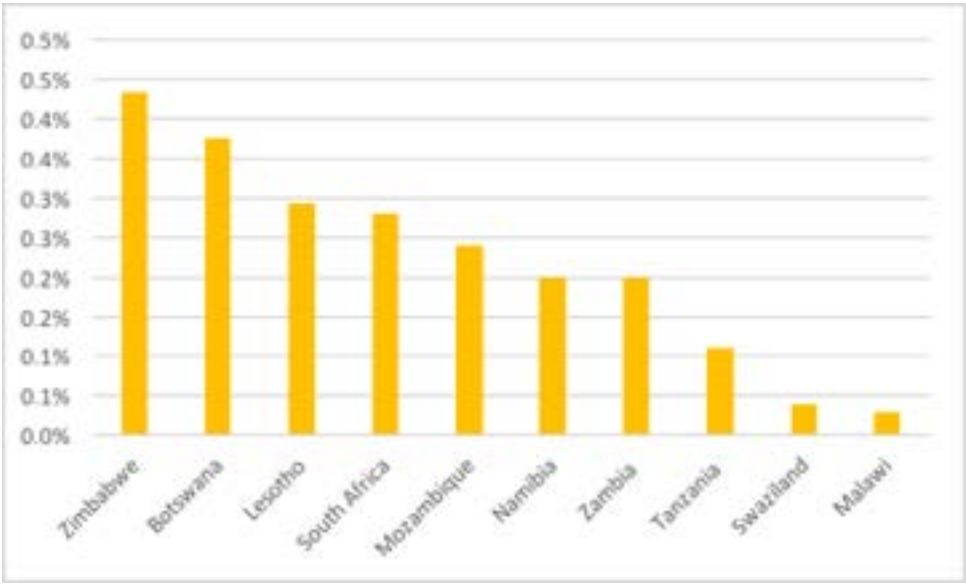


In terms of relative employment, the mining and quarrying sector is most important in Zimbabwe, followed closely by Botswana (Figure 1.4)

■ Figure 1.4

Relative employment in the mining and quarrying sector in selected SADC countries

See individual country sections for data sources.

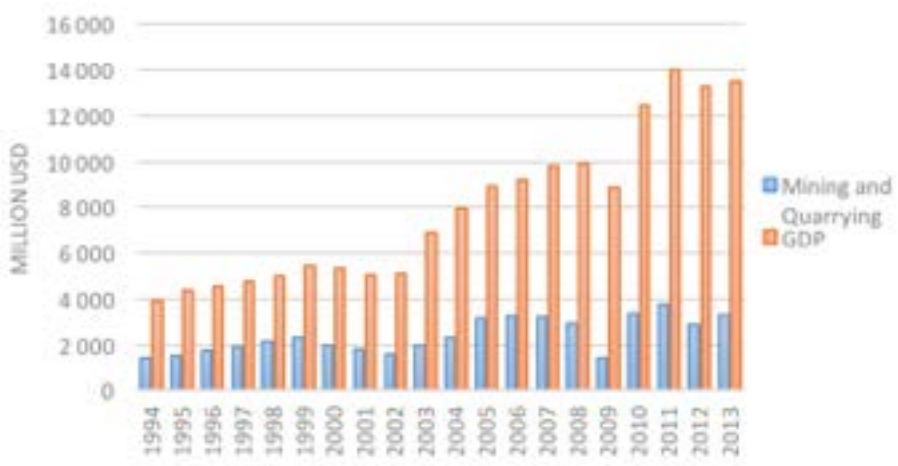


Country Overview

The brief summaries presented below are based on US Geological Survey Minerals Year Books[2] for each country unless otherwise indicated (Figure 1.5).

Botswana

Figure 1.5
Historical contribution of mining and quarrying to the GDP of Botswana
Data: SADC

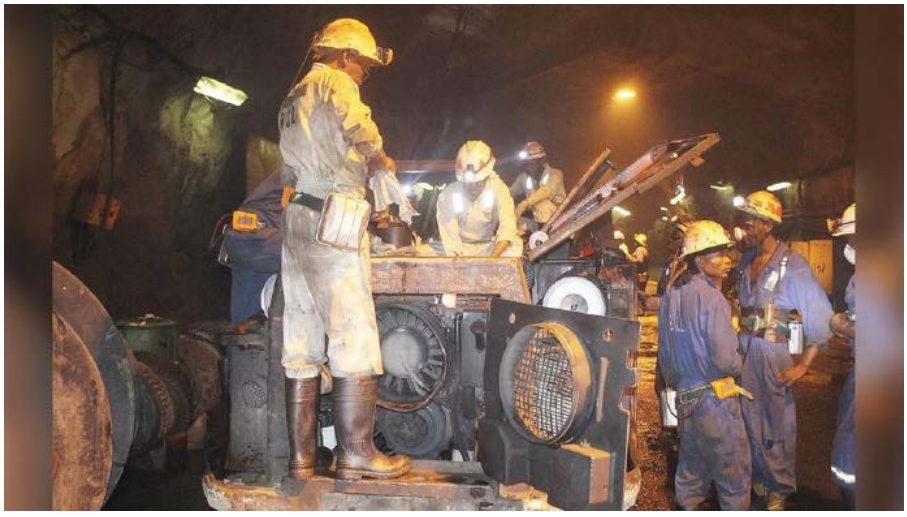


Of all the countries considered in this review, mining makes the largest contribution to the GDP of Botswana. Mining contributed 24,5% to GDP in 2013[2]. The most important mineral commodity produced by the country is diamonds. Botswana also mines copper, gold, nickel and soda ash.

The main mining centres are:

- Francistown (services),
- Selebi-Phikwe (base metals),
- Palapye (coal), and
- Orapa & Jwaneng, Lethlkane & Damtshaa (diamonds).

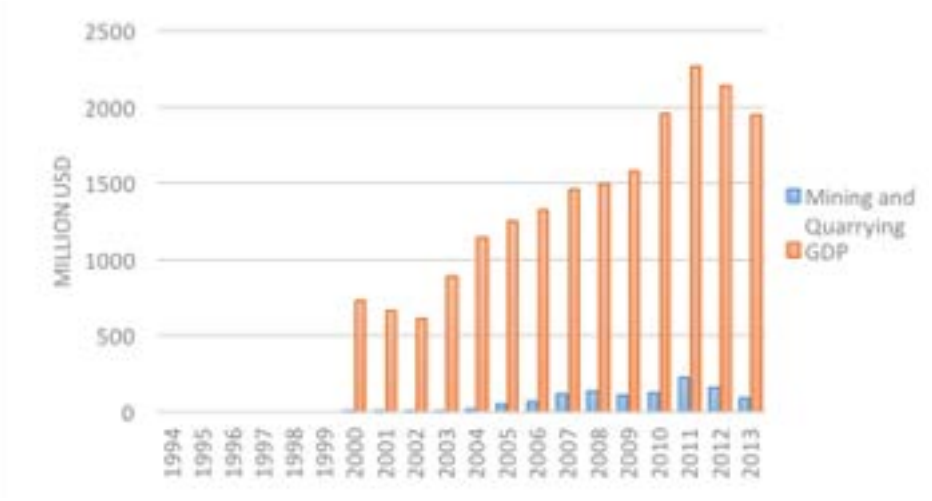
The main companies operating in Botswana are:Debswana (diamonds), BCL (base metals), Tati Nickel Co., Mupane Gold, IAMGOLD Corp., Lucara Diamond Corp., and Morupule (coal). Artisanal and small-scale mining (ASM) is not significant in Botswana. In the formal sector, employment in mining and quarrying accounted for 12 773 people out of a workforce of 340 107[3] in 2013.



Mining in Botswana

Lesotho

Figure 1.6
Historical contribution of mining and quarrying to the GDP of Lesotho
Data: SADC



The principal and only significant commodity mined is diamonds. The mining and mineral sector contributed 4,7% to GDP in 2013 (SADC) (Figure 1.6) increasing to 7,9% in 2015[4]. The sector employed approximately 2 000 people[5] in 2012.

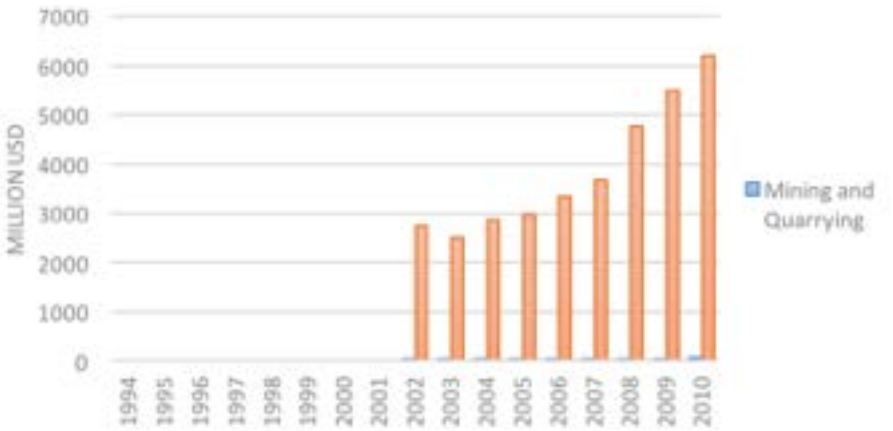
The main mining centres include the Liqhobong and Kao mines (diamonds) and Letšeng (diamonds). The main mining companies include: Gem Diamonds, Lucara Diamonds, Namakwa Diamonds and Firestone Diamonds. ASM has been historically important.

The country relies on a large migrant mining workforce. In 2005, some 52 450 Lesotho nationals were working outside the borders of Lesotho[6]. According to the 2008 Lesotho Integrated Labour Force Survey Statistical Tables[6], 42 933 people were employed in the mining and quarrying sector.

Open pit diamond mine in Lesotho *Image: et-global.com*

Malawi

Figure 1.7
Historical contribution of mining and quarrying to the GDP of Malawi
Data: SADC



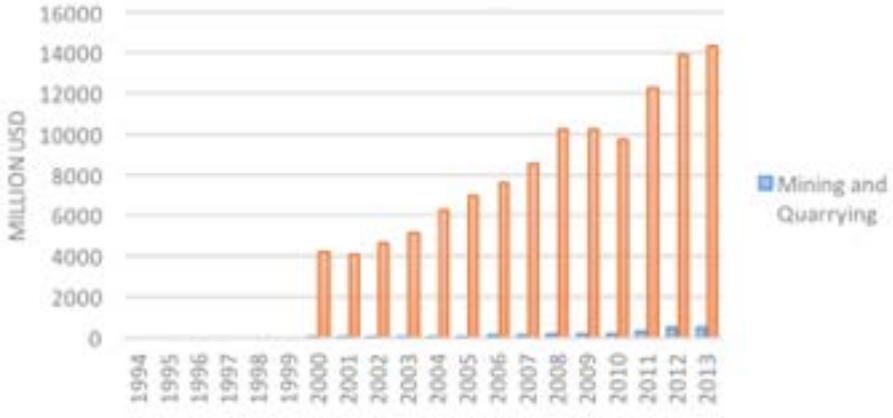
Mining contributed 2,3% to Malawi's GDP (Figure 1.7) in 2010 (SADC). Uranium is Malawi's principal mineral commodity. Other commodities include gemstones, coal, bauxite, niobium, tantalite and zirconium.Mining centres: Kayelekera Mine (uranium), Livingstonia and Rumphi mines (coal); Kanyika (rare earths). Few international mining companies are represented in the country. The most recognisable company operating in Malawi is Paladin (uranium). Aggregates, brick clay, gemstones and lime are produced by the ASM sector.

The mining and quarrying sector accounted for 0,3% of total employment in Malawi in 2013 (approximately 16 500 people)[7].

Gemstone Mining in Malawi

Mozambique

Figure 1.8
Historical contribution of mining and quarrying to the GDP of Mozambique
Data: SADC



Mining contributed 3,5% to GDP (Figure 1.8) in 2010[1].. The principal mineral commodities produced in Mozambique include aluminium, ilmenite and zircon. Other commodities include beryl, tantalum, coal, cement and graphite. Several large mining companies are present including: Pan African Resources, Noventa (niobium and tantalum), Kenmare Resources (heavy mineral sands), Cimentos de Portugal, Vale and Jindal Steel and Power (coal). ASM is an important component of the economy in general and mineral sector in particular. The World Bank estimates that 150 000 people are involved in producing gemstones and gold. In 2003, the mining and quarrying sector employed 41 800 people (2,4% of the workforce)[8]. By 2008, this had reduced to 0,2%[9].

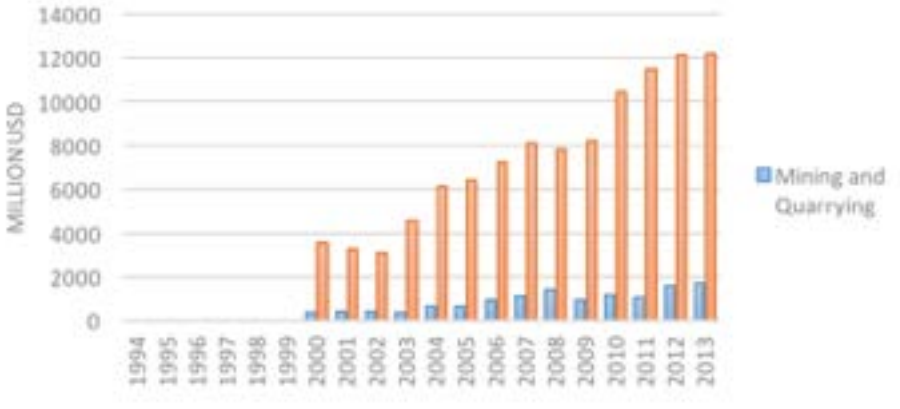
Artisanal coltan miners in Mozambique *Image: brg.bund.de*

Namibia

Figure 1.9

Historical contribution of mining and quarrying to the GDP of Namibia

Data: SADC



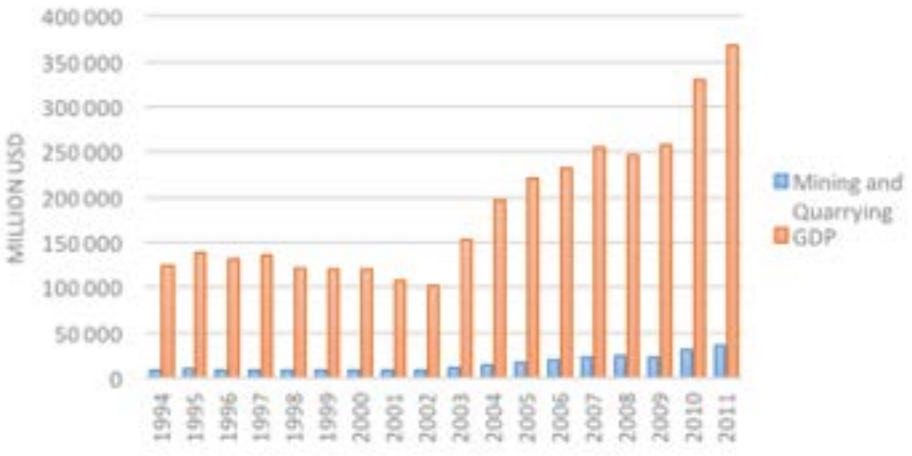
While Namibia has long been an important mining country, the principal commodity (by value) is diamonds. Other commodities include manganese, fluorspar, copper, lead, zinc and uranium. The contribution to GDP by the sector amounted to 13,8% in 2013, up from 10,4% in 2010[1] (Figure1.9). Principal mining centres include: Navachab (gold), Swakopmund (uranium) and Oranjemund (diamonds). Mining companies operating in the country include: Weatherly (base metals – Kombat, Matchless, Otjihase mines), Skorpion Zinc, Rosh Pinah, and Namdeb (diamonds).

ASM is significant in some commodities. The formal mining sector (as measured by the Namibian Chamber of Mines) provided 8 853 direct jobs at the end of 2015[10]. This estimate is considerably lower than the official figure of 13 558 (2% of the workforce) reported by Namibia Labour Force Survey in 2013[11].

Rossing pit, Namibia *Image: Wikipedia*

South Africa

■ Figure 1.10
Historical contribution of mining and quarrying to the GDP of South Africa
Data: SADC

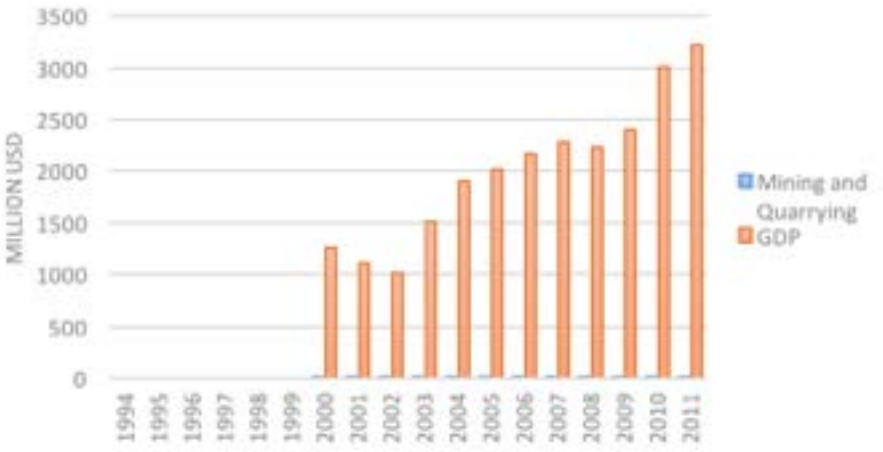


South Africa is the largest economy in the region. Mining and quarrying forms an important but declining component of this diverse economy, contributing 8,3% to GDP (Figure 1.10)in 2013 and employing 524 632 people (2012)[2]. By the last quarter of 2014, this number had declined to 427 000 (approximately 2,8% of the workforce)[12]. Principal commodities produced include platinum group metals (PGMs), chromium and gold. Others are coal, kyanite, vanadium, vermiculite, zirconium, manganese, heavy mineral sands, iron ore, nickel, copper, lead, zinc, cement and uranium. Mining centres: West Wits, Bushveld Igneous Complex (Eastern, Western, Northern Limbs), Mpumalanga coal fields, Sishen (iron ore), Black Mountain (base metals), Richards Bay (heavy mineral sands, aluminium production) and the Northern Cape (manganese). Mining companies: Samancor, Glencore, Assmang, Anglo Platinum, Impala Platinum, Lonmin, Palabora Copper, Gold Fields, Sibanye, AngloGold Ashanti, Harmony Gold, Gold One, Kumba Iron Ore (Anglo American), Exxaro Resources, Vedanta, Richards Bay Minerals, South 32, ARM, PPC and De Beers. ASM, both legal and illegal, is likely to become increasingly important as formal, large-scale mines reach the end of their operating lives and enter closure. Experience has shown that many of these sites are subsequently re-accessed by informal miners.

Coal open cut Middleburg SA *Image: iol.co.za*

Swaziland

■ Figure 1.11
Historical contribution of mining and quarrying to the GDP of Swaziland



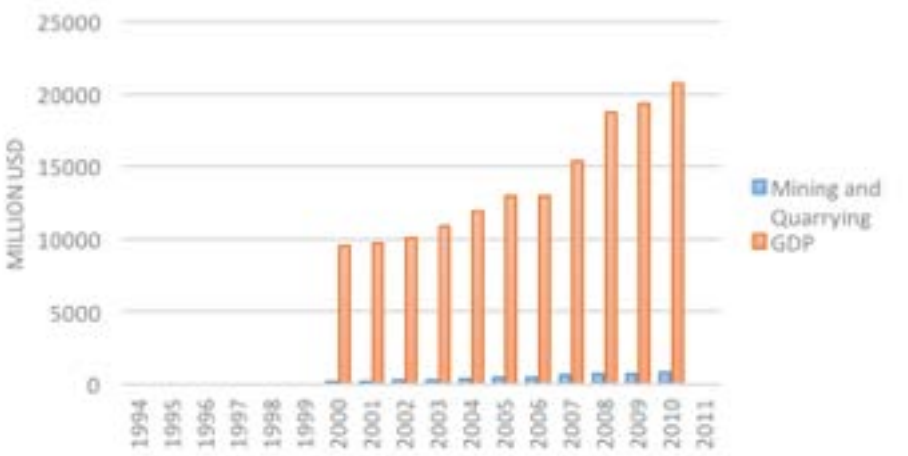
Mining has not played a dominant role in Swaziland's economy. Its estimated contribution to GDP is 2% (Figure 1.11)[13]. Swaziland's principal mineral commodities are iron ore and coal (anthracite). Other commodities mined include aggregates and diamonds. The country's mining centres are Maloma Mine (coal); Ngwenya (iron ore) and Dvokolwako (diamonds).

Mining companies operating in the country include Chancellor House and the Salgaocar Group India. ASM is important. About 600 Swazis are formally employed in the mining and quarrying sector, representing 0,4% of the formal workforce[14]. Many more (5 000 to 16 000) have been employed historically on South African mines[15].

Historical photo of the Havelock asbestos mine (Bulembu) *Image: ozoutback.com*

Tanzania

Figure 1.12
Historical contribution of mining and quarrying to the GDP of Tanzania
Data: SADC



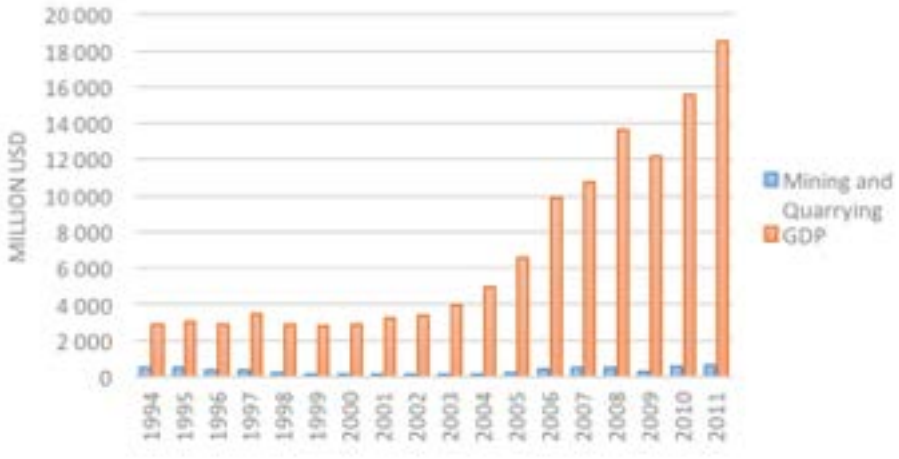
Tanzania's principal products are gold and tanzanite. Other commodities include limestone, gypsum, diamonds, lime; marble, sapphire, phosphate, cobalt, nickel, cement, graphite, rare earths, coal, and uranium[2]. The sector's contribution to GDP was 3,6% in (Figure 1.12) 2010[1.] and it formally employed 12 000 people in 2012.

Mining centres in the country include Bulyanhulu (gold), North Mara (gold), Merelani/Arusha (tanzanite), the Ruvumu District (coal) and Mujuku (uranium). Mining companies: Richland Resources (tanzanite); MMG (base metals); Barrick Gold, Glencore (base metals); African Barrick Gold (gold); AngloGold Ashanti, Resolute Mining (gold), Shanta Gold; Tanzanian Portland Cement Co.; Dangote Cement; Petra Diamonds; Kibaran Resources; Neelkanth Lime Ltd.; Peak Resources Ltd. (rare earths); Intra Energy (coal) and Uranium One. The ASM sector is important. Some 670 000 miners produce coloured gemstones, diamonds, gold and crushed stone. Other estimates put the number employed in the ASM sector at 1,5 million[16]. Mining and quarrying accounted for 1,1% (23 600)[17] of total formal employment on the Tanzanian mainland in 2014.

ASM gold in Tanzania *Image: GOXI.org*

Zambia

Figure 1.13
Historical contribution of mining and quarrying to the GDP of Zambia
Data: SADC



Zambia has primarily been a copper producer all its recent history. Cobalt is a co-product produced by the copper mines. Other commodities include beryl, emerald, coal, gold, manganese, nickel, cement, rare earths and uranium[2]. The mining and quarrying industry's contribution to GDP recovered to 13,4% in 2013 (Figure 1.13). Approximately 56 300 people are formally employed in the sector.

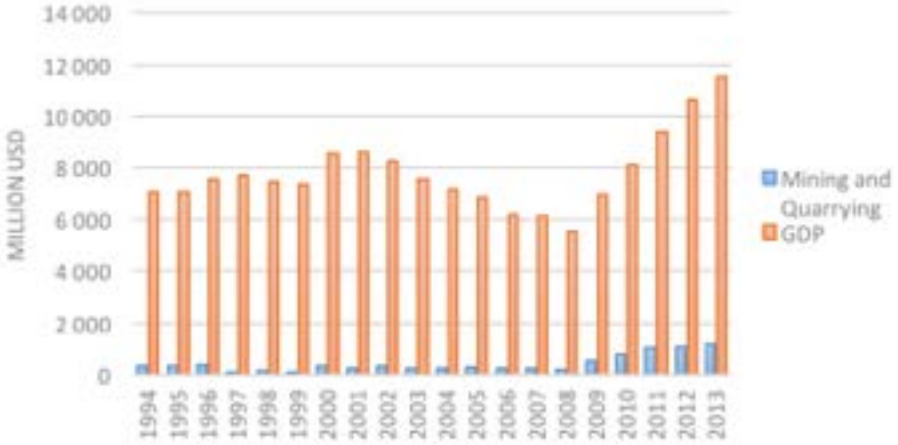
The country's mining centres are the Copperbelt Province, the "New Copperbelt" (located in North West Province) and Kabwe (lead/zinc). A number of tier one (large multi-nationals) and tier two mining companies operate in the country. A short list would include: ZCCM-IH (State-owned); Lubambe Copper (Konkola); ARM, Vale; China Nonferrous Metal Mining Corp (copper); Kansanshi Mining (First Quantum – copper, Au); KCM (Vedanta – copper); Lumwana Mining Co. (Barrick Gold – copper, Co, Au); Mopani Copper Mines (Glencore); Berkeley Mineral Resources, Kaboko Mining (manganese), Trident (FQM – nickel), Dangote Cement, Kagem Mining (emeralds) and Maamba Collieries.

ASM was not historically important, especially in the Copperbelt, but is playing an increasing role in the minerals sector. Mining and quarrying employed 2,0% of the workforce in 2008, some 92 810 people[18].

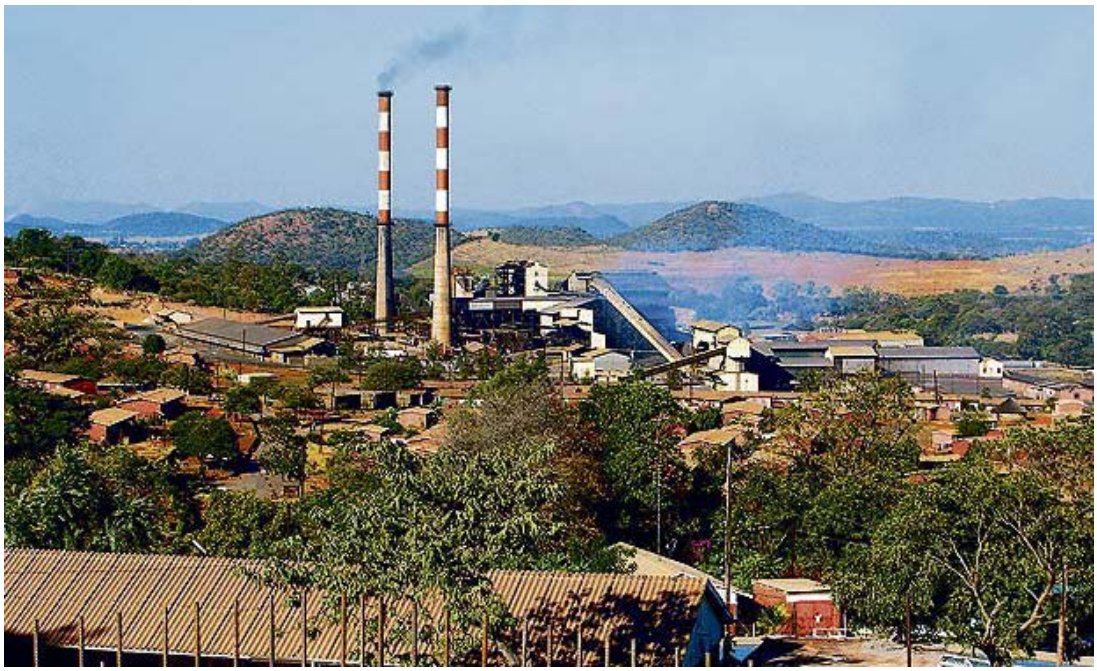
First Quantum Sentinel Copper Mine *Image: wsj.com*

Zimbabwe

Figure 1.14
Historical contribution of mining and quarrying to the GDP of Zimbabwe
Data: SADC



Zimbabwe's principal commodities are diamonds, gold and PGMs. Other commodities mined include coal, cobalt, copper, graphite, nickel, limestone, chromite, phosphate rock and wolframite (tungsten)[2]. In 2013, the contribution to GDP by mining and quarrying was 10,3% (Figure 1.15)[1]. Between 30 000 and 35 000 people are employed in the minerals sector[19]. Mining centres in the country include Bindura (nickel), Hwange (coal), the Great Dyke (PGMs) and the Chiadzwa area (diamonds). Mining companies: Marange Resources (diamonds), Mbada Diamonds, MMCZ, ZMDC, Industrial Development Corporation of Zimbabwe (last 3 are state owned), Mwana Africa (nickel), Mimosa Holdings (Impala Plats - PGMs), Zimplats Holdings (PGMs), Unki Mines (Anglo – PGMs), RioZim (copper), and Murowa Diamonds (Rio Tinto). ASM is important and becoming more so. There are substantial alluvial gold and diamonds operations in Zimbabwe that support upwards of 500 000 informal miners. In 2012, the last year for which employment data is available, the Zimbabwe National Statistics Agency[20]. reported that 44 100 people were employed in mining and quarrying.



Bindura Nickel *Image: newzimbabwe.com*

Mine safety and health

Mine health and safety under colonialism and apartheid

Mining history in the region is profoundly shaped by the injustices of colonial rule and South Africa's apartheid years, specifically the migrant labour system associated with South African gold mining. Under this system labour was drawn for decades from "labour-sending areas" in Malawi, Mozambique, Lesotho, Swaziland and South Africa.

Mining under colonialism and apartheid was hazardous and many mineworkers lost their lives. Towards the end of the apartheid era, South African gold mining alone claimed the lives of between 500-700 mine workers a year, and estimates at the time were that 66 000 mine workers had died in mine accidents and more than a million had been seriously injured since the turn of the century[21]. The 1995 Commission of Inquiry into Safety and Health in the Mining Industry, known as the Leon Commission, also concluded that tens of thousands of miners had contracted silicosis in the South Africa mining industry without the disease being diagnosed and without receiving the compensation to which they were entitled[22]. This was quantified in later research which stated that 200 000 mineworkers in South Africa and an estimated 80 000 in neighbouring states were entitled to awards[23]. The racism, discrimination and exploitation meted out to southern African mine workers, their families and communities still reverberates today.

Post-independence mine health and safety legislation in the SADC Region

After the advent of democracy in South Africa, several important policy interventions promoted mine health and safety. In the international environment, the International Labour Organization convention C176 (Safety and Health in Mines Convention, 1995 (No. 176)) requires countries to commit to consultation with employee representatives and to establish national mine health and safety law and policy. Article 5, 2(d) of the convention also requires the compilation and publication of statistics on accidents, occupational diseases and dangerous occurrences. Post-apartheid, South Africa moved quickly to ratify the convention and to promulgate the Mine Health and Safety Act (MHSA) No. 29 of 1996. As a consequence, South Africa's mine health and safety legislation is now world class, based on an approach to occupational health and safety regulation seen in other global mining contexts, especially Australia and Canada. Among SADC countries, Zambia, Zimbabwe and Botswana also ratified Convention 176. However, there are no further examples of dedicated mine health and safety legislation in the region and most countries include health and safety regulation as part of mining and minerals legislation (such as Namibia and Botswana) and/or under more general occupational health and safety legislation as found in Tanzania and Swaziland.

Despite significant new or revised legislation in mine health and safety, reporting related to occupational health and related compensation claims is weak. In South Africa, occupational health reporting and compensation are not found under the same piece of legislation. Compensation claims for lung disease are made under Occupational Diseases in Mines and Works Act (ODMWA no 78 of 1973 as amended). This legislation is administered under the Department of Health, in contrast to the Mine Health and Safety Act, which is the responsibility of the Department of Mineral Resources (DMR). Under ODMWA, the Medical Bureau for Occupational Disease (MBOD) and the Compensation Commissioner of Occupational Disease (CCOD) administer claims for compensation, but details of the last 10 years of compensation claims have not been published. In fact, the collapse of the compensation system for lung disease, both in lodging a claim, and the fact that compensation is a lump sum payment rather than a pension, has provoked an unprecedented class action case by former mine workers[24]. The case seeks damages from thirty-two mining companies on behalf of up to half a million mine workers who contracted silicosis and TB because of employer negligence. The case is propelling a government review of reporting occupational disease and injury and related compensation in South Africa. Presently, cases of occupational lung disease are reported to the medical inspector of mines in the DMR and published in the annual report of the Mine Health and Safety Inspectorate.

In other parts of SADC, similar problems beset occupational health reporting and compensation. Where legislation is applied it only has relevance to a fraction of the working population. In Tanzania, less than 20% of the working population is offered some protection under health and safety legislation and/or some access to occupational health services[25]. An ILO review of occupational health and safety in Zambia found that

reporting is much better to the Workers Compensation Fund Control Board than to the Mines Safety Department or Occupational Safety and Health Services Department, although most of this reporting seems concerned with accidents rather than disease[26]. Site visits by Centre for Sustainability in Mining and Industry (CSMI) to the Zambian Mines Safety Department in 2015 also heard that the enforcement of legislation was ineffectual and that the government regulator was severely under-capacitated[27]. A review of occupational health and safety organisation in southern Africa concluded that the success of these systems is constrained by the lack of training opportunities in the region for occupational medicine[28]. Therefore the existence, or not, of relevant policy is not enough on its own to ensure workplace health.

Post-independence, artisanal and small-scale mining (ASM) is part of the African Union's African Mining Vision[29]. Tanzania, for example, has great potential for this and artisanal miners have worked a range of minerals since the independence of the country in 1961. However, regulating the informal mining sector has proven difficult. Of great concern is the absence of an effective mechanism to protect miners from harmful workplace exposures. Given the absence of any effective framework or intervention, this may mean, for example, that exposures to particulate matter will be taken into the home on the clothing, skin and on the hair of mine workers. The only significant work in ASM health and safety has largely been confined to the use of mercury in gold processing. A recent review of health and safety in ASM found that four out of eight ASM scholars and practitioners surveyed in the review cited risks associated with working underground in poorly ventilated spaces including exposure to dust and respiratory disease in the top three health and safety risks to miners[30]. Studies of suspended particulate matter in ambient air that could have relevance to ASM indicate that mine workers and local communities are at risk of lung disease[31]. Control measures such as watering down are unlikely to be available to informal mine workers. A survey of ex-miners in Tanzania revealed that 45% ended their work in mining because of "unhealthy, hard and risky work [32].

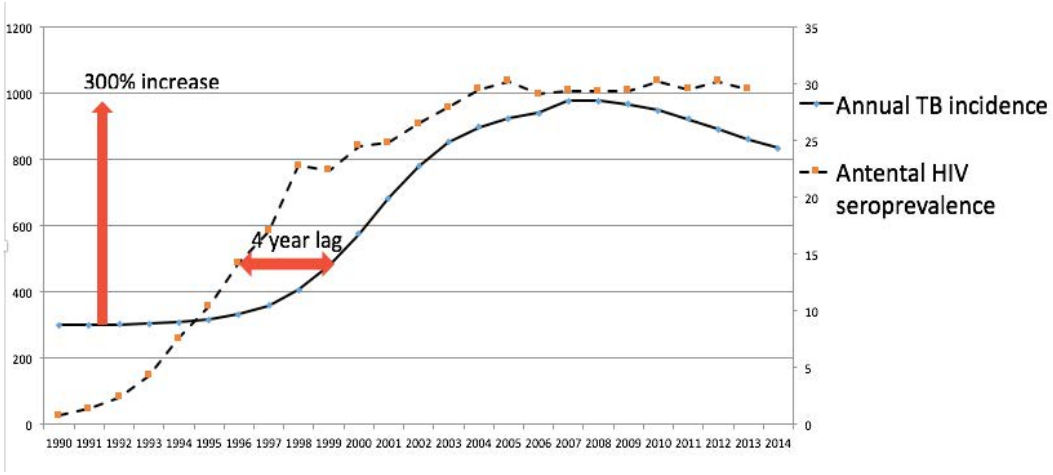
Challenges to mine health and safety performance

Despite significant advances in mine health and safety legislation especially in South Africa new cases of silicosis continue to be reported and a high incidence of TB on South African mines persists. Occupational health legislation has not eradicated decades of hazardous work practice on the mines. Poor dust control is the major contributor to occupational lung disease, despite national health and safety milestones being set in 2003 to eradicate new cases of silicosis,[33] and the establishment of the Mining Occupational Health Safety (MOSH) Leading Practice Adoption System, a sector-wide initiative to tackle priority health and safety hazards including dust[34]. One underlying explanation is that mine workers' pay is still partially paid through incentivized bonus payments that drive underground production teams to reach monthly targets. These payments are deeply entrenched in South African mining culture, and encourage the common practice of taking short cuts, with and without a supervisor's tacit or blatant support. Likewise, legal mechanisms such as the "right to withdraw from a dangerous workplace" (Section 23 MHSA) is hampered in practice by bonus payments, the legacy of racism, and fear of reprisals. Employees and their elected representatives do not as a matter of course exercise this right, citing fear of job loss, and conflict with supervisors (who may be white) and with fellow workers who fear missing production targets, as reasons for this [35].

Safety concerns dominate health on mines. Worker-elected health and safety representatives on South African mines report to the mine safety department and are inadequately prepared to address health concerns. Thus, exposures to dust go unchallenged, despite dust being a concern for workers. Even today, myths such as that drinking milk combats dust exposure can be found among miners. A contributing factor is that occupational hygiene and medical surveillance are often poorly coordinated on large mine operations. Often on South African mines, lagging rather than leading indicators prompt a response. For example, medical surveillance identifies individuals unfit for work who require evidence about exposures at the workplace to make a claim for compensation. At the mine health and safety committee, where employee and employer representatives come together, there is often a leadership gap on health. In other SADC countries, global senior mining companies are likely to state compliance with international health and safety management systems, specifically OHSAS 18000 or 18001 and sustainability reporting frameworks such the Global Reporting Initiative (GRI). However, without a strong regulator practice may be poor and the historical marginalization of health issues in mining perpetuated.

■ Figure 1.15

TB incidence and Antenatal HIV seroprevalence 1990 to 2014.



The social and other impacts of mining

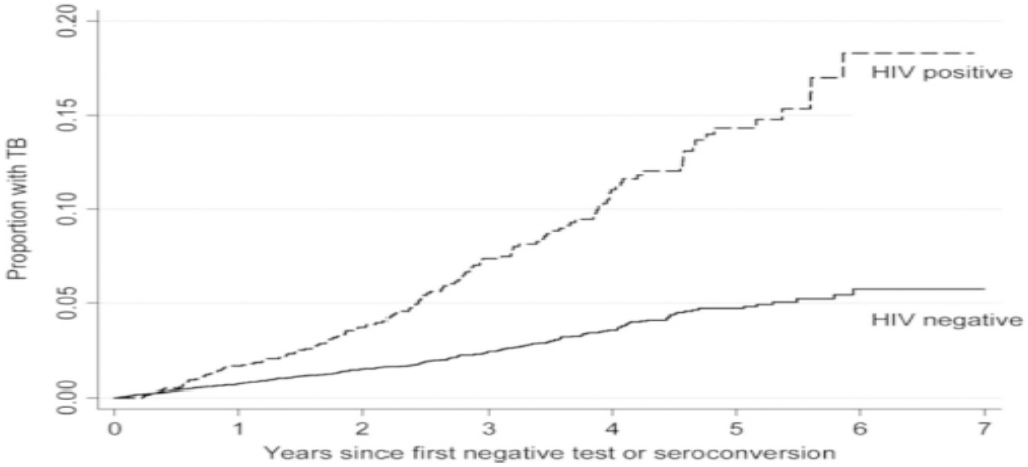
Mining regions present a range of psychosocial, socio-economic and environmental hazards for local communities and employees living in these areas. These hazards are linked to both the mining life cycle (exploration to closure) and to the status of the commodity market (up or down). They put both mine employees and local communities at risk for disease, mainly because of poor living conditions, social vulnerability and inadequate control of exposures and rehabilitation of mined land. Communities living close to mines may be exposed to dust, air pollution, water contamination and radiation, all of which contribute to ill health. Many mining regions in Southern Africa are poor or fractured either because of the rapid uncontrolled in-migration in periods of mineral boom or because of rising levels of unemployment and stark economic decline in periods of mineral downturn. Both scenarios exact severe social consequences and the associated high burden of disease. For example, local infrastructure, such as water, sanitation and roads, and services such as health, are not designed for the rapid growth of mining areas. Local communities are cheated of access to health services as the services struggle to manage the burgeoning population.

The mining industry has contributed significantly to the poor living conditions faced by many South African mine workers today. This is despite changes to the oscillating migrancy associated with mineworkers coming to work for extended time periods from traditional labour-sending areas. The "living out allowance" made available to mineworkers in South Africa during the late 1990s has meant a generation of mineworkers who support two families; one family staying in the traditional labour sending area and the second living in an informal settlement on the periphery of the mine operation. As a consequence, studies in South Africa report, mineworkers struggle with financial stress and are heavily indebted as they fight to maintain two families. Financial stress encourages mineworkers to chase production bonuses, take short cuts in health and safety practice and may contribute to the use of drugs and alcohol. A study commissioned by the South African Safety in Mines Research Advisory Committee in 2003, and carried out across seven mines, showed that the percentage of study participants that were likely to be dependent on alcohol varied from 10% to 25% (versus 10% among the general adult population); the prevalence of cannabis use across the same study mines ranged from 5% to 22%[36]. In South Africa a 10% quota for women in mining has introduced women into underground production teams. In addition to workplace exposures women entering the mine workplace have faced sexual harassment, abuse and rape.

In the informal mining sector, the risks to psychosocial and socio-economic wellbeing are frequently more severe, principally because the work falls outside of legal and regulatory frameworks, and in many cases, is carried out at subsistence level to secure meagre livelihoods, under arduous working conditions. In many cases, the work is manual and carried out by individuals or families. In these harsh working environments where work is very often seasonal, psychosocial concerns include child labour; violence and bullying against vulnerable and indigent populations; conflicts between mining migrants and local residents, large-scale mining companies, the police and security forces and organised crime; and a sex trade.

■ Figure 1.16

Cumulative Hazard Estimate of Tuberculosis in mineworkers by HIV status



TB and HIV overall prevalence and interactions

HIV is by far the most potent risk factor for progression to TB disease: the swift rise in HIV prevalence in the 1980s and thereafter in most sub-Saharan African countries was followed rapidly by a doubling or even tripling of annual TB incidence. In the Southern part of Africa, the baseline annual TB incidence before the HIV epidemic was already high (Figure 1.15). Then in Lesotho, Swaziland and South Africa the TB epidemic driven by HIV escalated, and they became the three leading countries by annual TB incidence, with ~1% of the population being treated for TB each year before prevention efforts, primarily antiretroviral therapy, became more widespread and accessible[37].

Over the past two decades, great strides have been made in identifying interventions that are proven to reduce new HIV infections [37]. Implementing these interventions on a wide-enough scale to ensure a measurable and sustained reduction in new HIV infections, however, has been difficult. Nonetheless, widespread access to antiretroviral treatment has reduced mortality and morbidity from HIV, and at a country level has resulted in reduced rates of TB[38]. New strategies to start ART immediately – irrespective of the progression of the virus – have already reduced mother-to-child transmission of HIV, and immediate initiation of ART together with provision of male circumcision, will help to curb future HIV transmission.

HIV in sub-Saharan Africa is primarily transmitted via heterosexual intercourse and the largest risk group is young women. Although there is greater recognition of the roles of key populations, sex workers and men who have sex with men are two groups who have difficulty accessing testing and health care[39].

Once infected with HIV, in the absence of antiretroviral therapy, the usual course in most adults is gradual but inexorable reduction in immune competence, reflected in the CD4 count, the number of white blood cells that play a major role in protecting the body from infection. This falls from ≥500 cells/mm3 of blood to below 200 or even below 50 over 8-10 years[40]. Opportunistic infections are more frequent once CD4 counts drop to below 200, but data from miners in whom the approximate date of HIV infection could be estimated suggests that the risk of TB rises in the first six months after HIV infection (Figure 1.16) when CD4 cells are still likely to be well over 500 cells/mm3[39,41]. TB in HIV-infected people progresses more rapidly than HIV seronegative patients and is associated with a greater risk of relapse and a higher mortality[42].

Antiretroviral therapy is a potent intervention to prevent new cases of TB in HIV-infected people [43]. Moreover, preventive treatment (PT) against TB has proven efficacy in preventing new cases of TB and prevents mortality[44], although implementation of PT has been patchy, exacerbated by health worker suspicion, confusing regimens, and "stock-outs," or unavailability of medicines. Until three years ago, TB diagnosis, especially in HIV-infected people, was microscopic examination of sputum of a person suspected of having TB. In some cases, when the microscopic examination was negative but suspicion remained, a culture of sputum would be done to detect *Mycobacterium tuberculosis*[45]. Microscopy is an insensitive test in HIV-infected people and culture is expensive and may take between one and six weeks to obtain a

result[45]. More recent rapid, accurate molecular methods to diagnose TB have been tested and the Xpert MTB/RIF test (Cepheid) has, in several high burden countries, replaced older TB diagnostic methods[45]. Although large clinical trials found no evidence that Xpert MTB/RIF has contributed to improved TB treatment outcomes, it is likely that Xpert reduces TB transmission and morbidity related to TB, as the more rapid diagnosis of TB hopefully ensures TB treatment starts sooner[46].

Mining has clearly contributed to the spread of both HIV and TB epidemics. Several published papers by Corbett et al have both reported important aspects of the epidemiology of TB and HIV co-infection in South African miners and demonstrated the malign impact of the intersection of HIV, silicosis and TB. Firstly, rates of TB surged with the escalating HIV epidemic, but by 1999 in gold mining populations, TB rates were fourfold those of the entire country: approximately 4% of gold miners were diagnosed with TB every year[47,48]. Secondly, although rates of TB escalated overall, when stratified by HIV status, it appeared that rates of TB in HIV negative miners remained relatively stable at approximately 1 700 per 100 000 compared to rates of close to 8 000 per 100 000 in HIV positive miners[47]. The HIV-infected miners primarily bore the brunt of the TB epidemic – without increasing the rates of TB in HIV-negative miners[48]. It is likely that this pattern is mimicked in general populations outside of miners. Finally, data from miners has shown clearly that HIV-infected people with TB will visit medical facilities within a few months of developing symptoms – thereby restricting the time they are infectious compared to HIV-negative people who are more likely to tolerate their symptoms for a longer period before seeking care and diagnosis.

The impact of TB is felt not only in mineworkers themselves but also communities that send workers to mining areas. Although formal large scale studies of the impact of mining on such communities are rare, small single-site studies do provide insight. A forensic autopsy study conducted at the then-Umtata General Hospital in the Eastern Cape Province of South Africa reported rates of silicosis and TB in 200 adults who died from trauma (road injuries, suicide or interpersonal violence). This study suggested that at least 2% of all those who had a forensic autopsy had TB at the time of death and 2% of males had silicotic nodules[49]. Another study reporting risk factors for TB infection in Botswana showed that children who lived with a person who worked on mines, most likely in South Africa, had 2,8 times the risk of testing positive for TB compared to children who did not live with a miner[50]. The prevalence of TB in a sample of ex-miners in Lesotho suggested that 6% had prevalent active TB[11,51].

In conclusion, the generalized HIV epidemic exacerbated an existing TB epidemic, and particularly hit miners and their home communities. Enhanced access to long-term suppressive antiretroviral therapy is key to controlling the HIV epidemic and preventing new cases of TB in HIV-infected people. Other interventions to prevent TB need to be effectively implemented, and to have long term effects on curbing TB should be targeted at both HIV-infected and HIV seronegative people.

Silicosis in the mining industry

Silicosis, caused by exposure to crystalline silica, is a pneumoconiosis, and is characterised by the replacement of healthy lung tissue with nodules of fibrosis, mainly in the upper lobes of the lungs. It is a progressive and irreversible condition; the most severe form of the disease is termed progressive massive fibrosis. Those affected may, however, show no signs or have no symptoms of disease. Chest radiographs are the best diagnostic tool for the living, although cases might be missed using this method [52]; autopsy diagnosis is the most reliable indicator [53]. Silica dust exposure is also associated with chronic obstructive pulmonary disease, lung cancer, and immune-related diseases [54].

Because silicosis has a latency period of up to 20 years [55] it may develop only after people are no longer exposed to silica dust, or have retired from working in the environment where they were exposed. This late onset, and progression of disease, was demonstrated in an early cohort study on white ex- gold miners. In 1993, Hnizdo et al calculated silicosis prevalence as 14% in this cohort [56]; the prevalence had increased to 52% by 2004. The prevalence of silicosis in ex- gold miners living in Lesotho increased from 26,6% to 27% over a period of 12 months.

Silica dust exposure occurs mostly in mining and mining-related occupations, e.g. milling, quarrying, tunnelling and excavation; but workers in the agricultural and construction sectors are also at risk of exposure [55]. Silicosis is diagnosed most frequently in gold miners.

Prevalence of silicosis in gold miners in southern African countries

Few epidemiological studies have been published on the prevalence of silicosis in southern Africa. Available figures are summarised in Table 1.1. The different studies have used various study designs, diagnostic tools and sub-populations from which to estimate rates. Because of the latency period and progressive nature of the disease, studies that include ex-workers are likely to report more accurate estimated rates of silicosis.

South Africa

Ten studies have been published on the prevalence of silicosis in gold miners and ex-miners in South Africa, from 1978 to 2015. The studies have been conducted using data from both white and black miners, living and dead. Estimated prevalence rates range from 1,4% in employed black miners in 1984[59]. to 51,6% in deceased white miners in the period 1968 – 2003[57].

Findings from a white gold miners' cohort study from which three papers have emanated, illustrate the progression of silicosis long after retirement: from 7% reported in 1978,[60] to 14% by 1991,[56] to nearly 52% in 2004[57].

While early research showed low disease rates in black gold miners,[59] later studies reported that the rate had increased to 22-36%[61]. Churchyard et al., (2004) reported that silicosis rates in black employed gold miners in 2000/2001 were 14 times higher than reported in 1984[62]. This reflects the employment patterns on the gold mines: before 1984, black mine workers were employed on short-term contracts.

Many of the studies are cross-sectional, had small study populations, and used X-rays to diagnose silicosis. All these factors limit the validity of the findings, resulting in under-estimates of disease prevalence. The most robust findings are from a trend analysis by Nelson et al., in which the prevalence rate in 2007 among black miners was 32% and among white miners was 22% (Table 1.1)[63].

In summary, all these studies provide evidence that historically, and currently, there is a high prevalence of silicosis in gold miners, particularly black gold miners, in Southern Africa. These high rates of silicosis in the South African mining industry have been attributed to the migrant labour system and historical labour practices[64].

Other countries

Only three studies of the prevalence of silicosis in gold miners have been conducted in countries outside of South Africa: one in Botswana[65] and two in Lesotho[66]. All of them were on living, black, ex-miners and all reported high proportions of silicosis, from 24,6% to 31%.

Interaction between silicosis and TB

Exposure to silica dust and silicosis itself are both associated with tuberculosis, or as it is commonly known, TB. It is believed that the Cornish tin miners who came to South Africa to work in the mines on the Witwatersrand brought the bacillus with them[67]. Mine dust and the miners' poor living conditions helped the TB spread. Mine workers who contracted TB were sent home to their rural communities, further spreading the disease in these areas.

The association between silicosis and TV was first noted by Gorgas in 1914,[68] and silicosis has been a cause for concern in the South African gold mines since around this time. More than 100 years later, this concern is greater than ever, especially as South Africa gold miners have one of the highest TB rates in the world[69].

Even in the absence of HIV, silicosis is a risk factor for tuberculosis[70]. Together, HIV, silicosis and exposure to silica dust have a multiplicative effect on the development of tuberculosis on the South African gold mines[71]. The HIV epidemic, however, together with inadequately controlled silica dust exposure, has resulted in an out-of-control tuberculosis epidemic in the gold mines.

Economic impact of TB and silicosis in the mining industry

Tuberculosis and silicosis in the mining sector impose costs on miners, employers and society.

Ill and disabled miners and ex-miners bear the directs costs of care. Employers face directs costs of reduced productivity and higher production expenses when miners are unwell, and must pay for health care and screening for active miners, as well as, in countries such as South Africa and Zambia, levies to pay for compensation funds. Public and private health sectors also pay a broader social cost for health care of miners with TB and silicosis who present after retrenchment, normal retirement or ill-health retirement. Multi-drug-resistant and extremely

■ Table 1.1 Epidemiological studies of silicosis in South African gold miners, 1978 – 2010 (adapted from Nelson, 2012)

Authors	Study design	Study period	Study Population	Sample size	Mean/range of employment (years)	Diagnostic tool	Proportion with silicosis (%)
South Africa							
Irwig and Rocks 1978	Cross-sectional	1968 to 1971	Employed white miners 45-54 yrs	1 973	> 10	Chest X rays	6,8 (1971)
Cowie and van Schalkwyk 1987	Cross-sectional	1984	Employed black miners	132 765	Not stated	Chest X rays	1,4
Murray et al. 1996	Cross-sectional trend analysis	1975 to 1991	Deceased black gold miners	16 454	4,4 - 6,9	Autopsy	9,3 (1975) -12,8 (1991)
Hnizdo and Sluis-Cremer 1993	Cohort	1968 to 1991	White ex-miners - living and dead	984	23,5	Chest X rays	14.0 (1991)
Trapido et al. 1998	Cross-sectional	1996	Living black ex-miners	238	12,2	Chest X rays	22.0 - 36.0
Meel 2002	Cross-sectional	1997 to 1999	Living black ex-miners – hospital patients	300	Not stated	Chest X rays	34,0
Churchyard et al. 2004	Cross-sectional	2000 to 2001	Employed black miners older than 37	520	21,8	Chest X rays	18,3 - 19,9
Murray and Hnizdo 2005	Cohort	1968 to 2003	Deceased white gold miners	1 476	23,5	Autopsy	51,6 (2003)
Nelson et al. 2010	Cross-sectional trend analysis	1975 to 2007	Deceased black and white gold miners	19 143	Black: 13,4 (2007) White: 20,1 (2007)	Autopsy	Black: 32.0 (2007) White: 22.0 (2007)
Knight et al. 2015	Cross-sectional	2004 to 2009	Employed black miners	11 557	Not stated	Chest X rays	5,7 - 6,2
Botswana							
Steen et al. 1997	Cross-sectional	1994	Living black ex-miners	304	15,5	Chest X rays	26,6 – 31,0
Lesotho							
Girdler-Brown et al. 2008	Cross-sectional	1999	Living black ex-miners	624	25,6	Chest X rays	24,6
Park et al. 2009	Cohort	1999 to 2000	Living black ex-miners	553	26,1	Chest X rays	27,0

drug resistant TB is particularly costly to treat.

TB and silicosis also have indirect costs. Miners have reduced ability to work and earn, and this affects them, their households and communities, which are also put at higher risk of HIV and TB infection and related costs. Household caregivers of miners with active or disabling TB and silicosis face costs of time and other resources used in caring. Externality costs can also be substantial. This is when employers do not bear the full costs of creating environments that have high TB, HIV and silicosis risk, or the full costs of HIV and TB infections that may emerge in the miners' communities. Compensation systems and mine health services may not reliably ensure that mines bear the cost of remedial measures for miners and their communities. Similarly, miners who do not adhere to treatment may impose costs through spreading infection among other miners and their households. Poor communities tend to feel the greatest burden of indirect costs. However, mining companies can experience reputational costs and less investment due to concerns about future liabilities to compensate employees who have developed TB or silicosis.

Relatively little information is publicly available about the size of costs related to TB and silicosis in southern Africa, despite the high proportion of employment and economic output generated by mining in countries of the region. However, the World Bank estimated that 9,6-million work days are lost in the region's mining sector each year due to TB. In South Africa alone the annual financial cost of the productivity losses was estimated to be almost US $568-million . Miners themselves bore an additional US $320-million in lost wages. The annual cost of testing and treating all mineworkers in South Africa was estimated to be about US $33-million in 2012. However, treatment of TB was estimated to have a 40 to 1 benefit-cost ratio suggesting US$1 billion in benefits to society from this level of testing and treatment. The World Bank estimated that investing around $500 million year in health and social programs targeting miners could produce benefits that exceed the costs of inaction by more than US $780-million[72-74].

Costs to miners and their communities are exacerbated by uncompensated TB and silicosis. Practical barriers, including lack of awareness, legal and bureaucratic complexities, and diagnostic requirements prevent people from accessing benefits[75]. The backlog in compensation of medically certified claims stuck in the South African Occupational Disease in Mines and works Act (ODIMWA) administration was estimated by the Commissioner to be 104 000 and the Medical Bureau for Occupational Diseases had an estimated backlog of 8 000 claims in 2014/1576. Among former miners in Eastern Cape, only 2% of those with compensable silicosis had received compensation, while an audit of the mining companies' Compensation Fund found that less 1,5% of claims were paid out[77,78]. The value of unpaid occupational lung disease compensation in the last two decades has been estimated at times to be about R20-billion (US $1,5-billion), and resulting lawsuits have resulted in further costs[79,80].

Economic incentives complicate ability to obtain good epidemiological information on TB and silicosis in the sector. For example, employers may be reluctant to release information on TB and silicosis levels that could lead to claims. Miners themselves may avoid diagnosis if it could lead to loss of employment.

Artisanal and small-scale mining

Introduction

Southern Africa has a wealth of minerals and the mining industry contributes a significant portion to the countries' economies[1,67]. The most commonly accepted method of defining the scale of a mine is by number of employees and annual turnover of the company[81]. Artisanal and small-scale mining is defined as a mining activity that employs less than 50 people and has an annual turnover of less than US$500 000[1]. The activities of the artisanal and small-scale mining (ASM) sector are largely poverty-driven, complementing more traditional forms of subsistence earnings[82]. The Mining, Minerals and Sustainable Development (MMSD) Southern Africa report (2002) acknowledges that ASM is "typically practised in the poorest and most remote areas by a largely itinerant, poorly educated populace, men and women with few employment alternatives"[83].

The ASM mining activities are often not legally registered, and moreover, the operations are extremely mobile and flexible, so no suitable quantitative studies have been done on ASM activities in southern Africa, and the reported number of ASM operators or employees varies in different reports[81,84,85]. An estimated 9-million people work in the ASM sector, by far the largest mining

workforce on the continent[3]. This number has surged and is expected to continue growing[81,83,84]. The ASM sector also employs more women, with about 25% of the miners in ASM being female, but despite that, men own most of the mines. There are also reports of child-labour within the ASM sector, ranging from helping parents after school to full-time employment[85]. However, the children are often not involved in digging, but rather with other duties related to mining like gold panning, fetching water and minerals processing[85].

The range of commodities artisanal miners exploit is diverse, and varies per country depending on the available mineral resources, market demand for the minerals, mining regulation and the level of large-scale mining[85]. In the SADC region, over 30 minerals are mined within the ASM sector[85]. The commonly mined minerals include lime, building materials, gemstones, gold and tantalite, as these are profitable; other minerals mined are salt, graphite, diamantes, ornamental stones, sand and talc [85].

While ASM constitutes important economic activity, it is associated with health, environmental and social hazards for miners and surrounding communities[82,86]. Some of the challenges of the ASM sector are the decreasing rural livelihood choices, an increase in the number of people considering ASM as option for employment, increasing poverty and increasing pressure on the countries' available mineral resources [87]. In addition to these, ASM do not have access to mineral rights registrations, financial services and support, market opportunities, and the necessary technology and there is poor compliance with health and safety and environmental regulations[85,87,88]. Most of the problems of small-scale-mining can be solved through working with government agencies and communities to improve working conditions and ensure sustainability of this industry[89].

ASM Health Challenges

The major difficulties integral to ASM practice make the workers vulnerable to high levels of inappropriate exposure and diseases, such as inefficient exploitation of marginal deposits; use of poor equipment and limited capital and skills; poor working conditions; low levels of safety and health; inadequate environmental management practices; and exploitation of workers, particularly women and children[84]. A lack of data, or unreliable data, means occurrences of disease in the small-scale mining regions have been poorly documented. Moreover, a lack of health-care focused specifically on this sector, makes it impossible to gauge the extent of rampant diseases[83, 84].

Most miners are unwilling to use their hard-earned incomes to improve their health practices, particularly where benefits cannot be realized in the short term. They therefore rely on self-help, public, and traditional health services in the event of illness or injury[84]. ASM workers are exposed (inhalation, contact, ingestion) to various chemicals during the mining process[90]. Some of the chemicals include mercury, cyanide and lead[89]. Mercury intoxication can cause neurological, kidney and autoimmune dysfunctions while cyanide causes fast breathing, tremors and death[90]. Biological hazards for the mineworkers also include musculoskeletal problems due to heavy manual labour, overexertion and physical trauma[90].

Due to poor compliance with health and safety regulations, noise, silica dust, gases and contaminated water exposures compromise the health of these people [90]. High numbers of occupational injuries are also associated with small-scale mining. Among the safety issues, most small-scale miners do not have personal protective equipment, increasing their risk of injury[85,90]. The most common causes of occupational injuries are inappropriate use of explosives, poor ventilation, rock falls and obsolete and poor quality equipment[91]. Miners also need to be trained in health and safety and be informed about how to overcome the risks of small-scale mining[10]. Alcohol and drug abuse similarly characterize the ASM sector resulting in violence, risky sexual behaviours, injuries, prostitution and criminal activities [90].

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"To collect, collate and analyse current and prior secondary data in the mining sector that describes the epidemiology of TB, MDR-TB, HIV/AIDS and silicosis in ten SADC countries."

Chapter 2: **Methodology**

Study Objective

The primary objective of the study was to collect, assimilate, and analyse available secondary data describing the current TB, multi-drug-resistant TB (MDR-TB), HIV and silicosis epidemics among current and ex-miners as well as their families and communities within 10 African countries: South Africa, Lesotho, Swaziland, Mozambique, Zimbabwe, Botswana, Namibia, Zambia, Malawi and Tanzania.

Study Aims

The study has five specific aims geared towards achieving the proposed objective:

1. To collect, collate and analyse current and prior available secondary data in the mining sector that describes the epidemiology of TB, MDR TB, HIV/AIDS and silicosis in the ten countries;
2. To collect additional information on TB, MDR TB, HIV and silicosis by interviewing key informants;
3. Analyse available data to provide country specific comprehensive baseline assessments that identify hotspots and areas with few data;
4. Provide recommendations on appropriate interventions at regional level for how to coordinate response to TB and related illnesses;
5. Disseminate study results to recipients of other TIMS Requests for Proposals (RFP) and also in research, occupational, and public health forums.

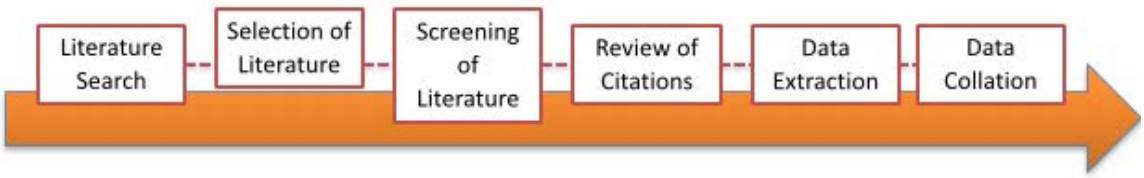
Two different methods of data collection were used to address the study aims and objective:

1. Systematic literature review
2. Individual interviews

Systematic Literature Review

Secondary data was collected through systematic literature review of published scientific papers and reports. Unpublished sources were also reviewed, including industry reports, PhD and Masters dissertations and conference presentations. The systematic literature review was conducted using modified Cochrane Collaboration guidelines[1,2] (Figure 2.1). These guidelines were used to direct the review processes and have been outlined below.

Figure 2.1
Modified Cochrane Collaboration Guidelines
Source: The Cochrane Library



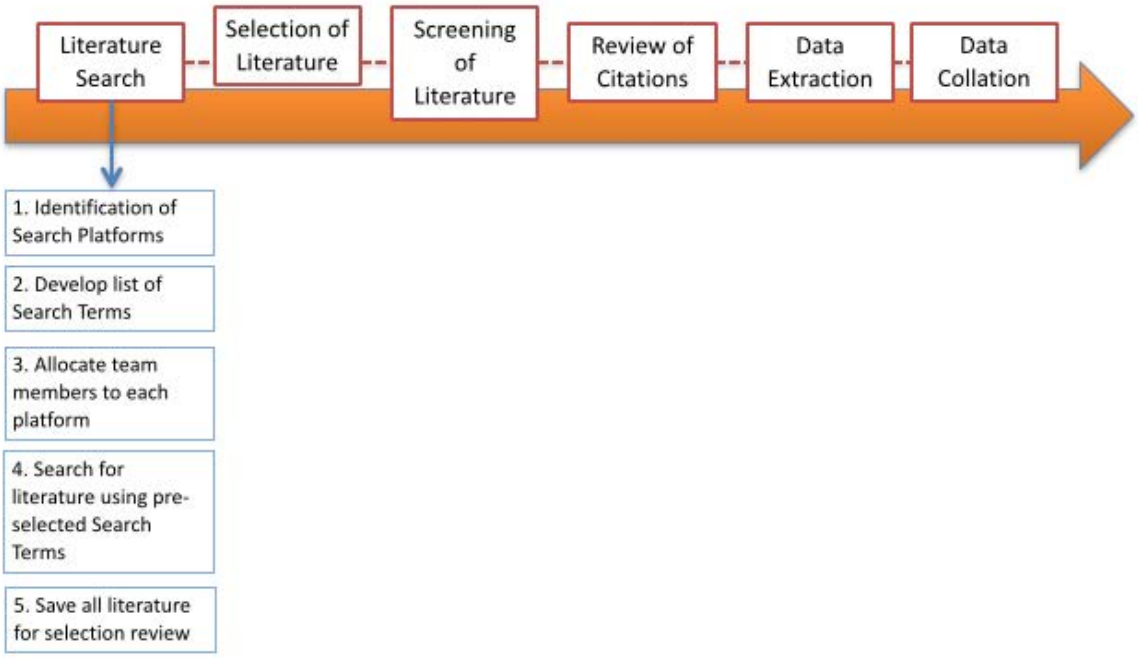
Literature Search Strategy

We used four search platforms to conduct the literature search: *Google Scholar, PubMed, EBSCO and OneMine*. These platforms were chosen because they provided a broad overview of varied mining literature that covered multiple disciplines such as: health, minerals and mining, socio-economic and history to name a few. The core study team developed a list of search terms that would generate the required literature to answer the study aims. Table 2.1 includes the list of search terms that were compiled for the literature search. A study team comprising of eight members was divided into four groups, two people per group, and each group was directed to use one of the search platforms and the preselected search terms in multiple combinations to look for publications (Table 2.1). The overall search team included personnel from various backgrounds: Epidemiology, Medicine, Statistics and Psychology. Only English language papers and reports published between 1990 and 2016 were included. A total of 165 366 manuscripts were generated using the preselected search terms and relevance to study (Figure 2.4). Across the four platforms Google Scholar generated the highest number of results (161 671), followed by OneMine (3157), PubMed (757) and EBSCO (538). All searched publications were recorded in a separate spreadsheet for selection review (Figure 2.2).

■ **Table 2.1 Search Terms**

Tuberculosis	Ex-miners	Miners	Medical surveillance in mining
TB	Miners health	Mine workers	Lung
HIV	TB treatment mines	TB mines	Commodity
Silicosis	MDR mines	HIV mines	Artisanal and small-scale mining
Mining	Africa	Silicosis mines	
Mines	Pneumoconiosis	Minerals	
Metals	Mining community	Quarrying	

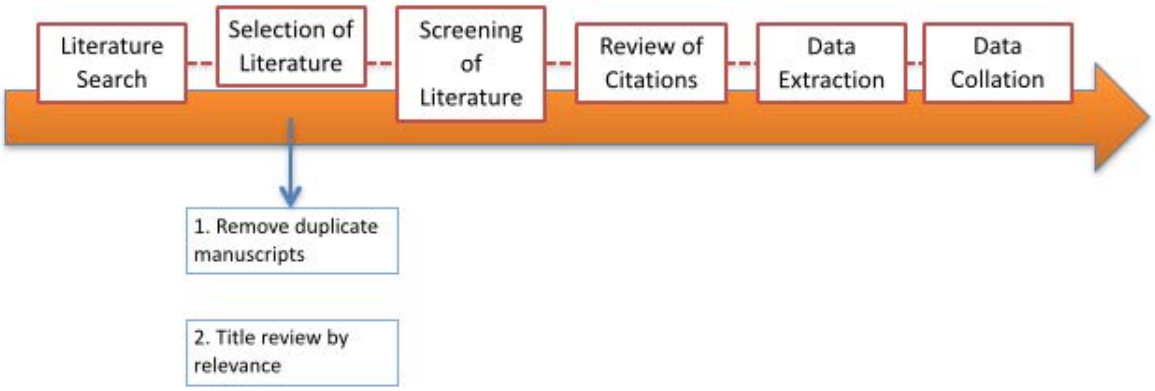
■ **Figure 2.2**
Literature Search processes



Selection of Literature

The search generated many duplicate manuscripts, of which 686 were removed. A review of the titles was conducted and only manuscripts referring to TB, MDR-TB, HIV and silicosis in miners, ex-miners, mining communities and the general population in each of the 10 Southern African countries or in Southern Africa as a whole were selected (Figure 2.5). A total of 164 479 manuscripts were removed due to unrelated manuscript titles (Figure 2.3). There were a total of 958 manuscripts, from the original literature search, that needed to be screened.

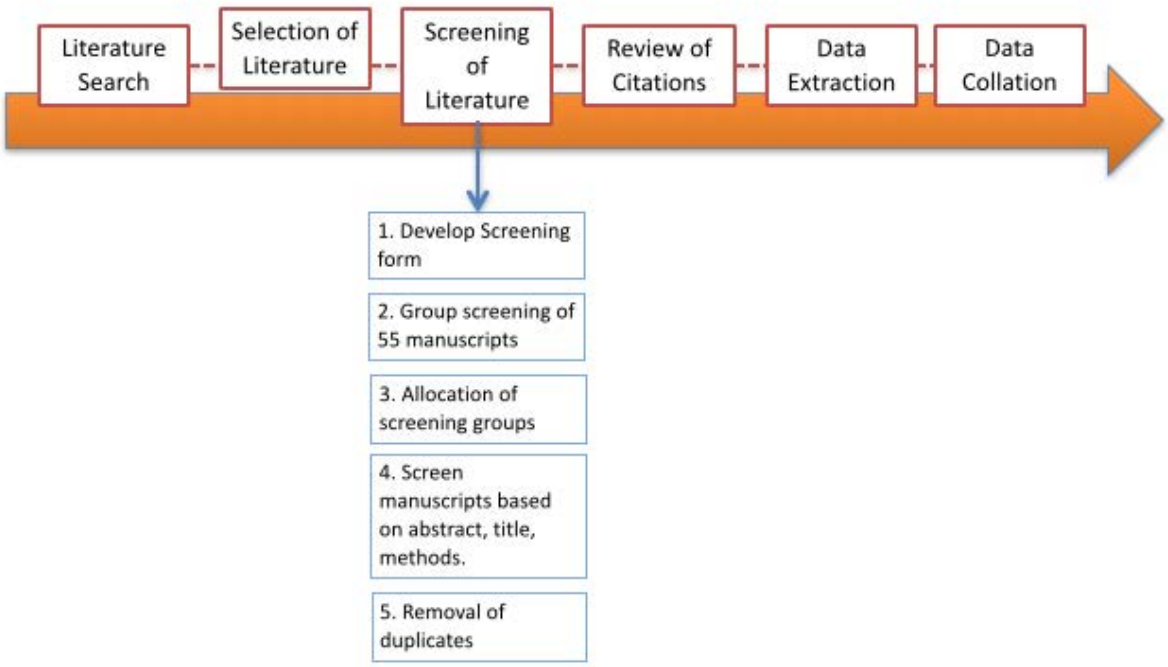
■ **Figure 2.3**
Selection of Literature processes



Screening Process

The remaining 958 selected manuscripts were copied into a separate Excel spreadsheet. The titles, abstracts and methods sections of the manuscripts were screened, using a study specific screening form, for eligibility (Figure2.4). The screening form was divided into four sections covering: date of manuscript publication, country that publication speaks about, types of mining and population, and health variables (HIV, TB, silicosis). The search team also conducted the screening process. Initially, the whole team screened the first 55 manuscripts together to ensure consistency in following the screening processes. Thereafter, the team was divided into four groups and each team of two screened the remaining manuscripts. A total of 342 manuscripts were considered relevant to the study objectives and were removed. The remaining 616 manuscripts were copied into a *master list* and any further duplicates were deleted (Figure 2.5).

■ **Figure 2.4**
Literature screening processes



■ Table 2.2 Summary of Abstract Review by country and topic

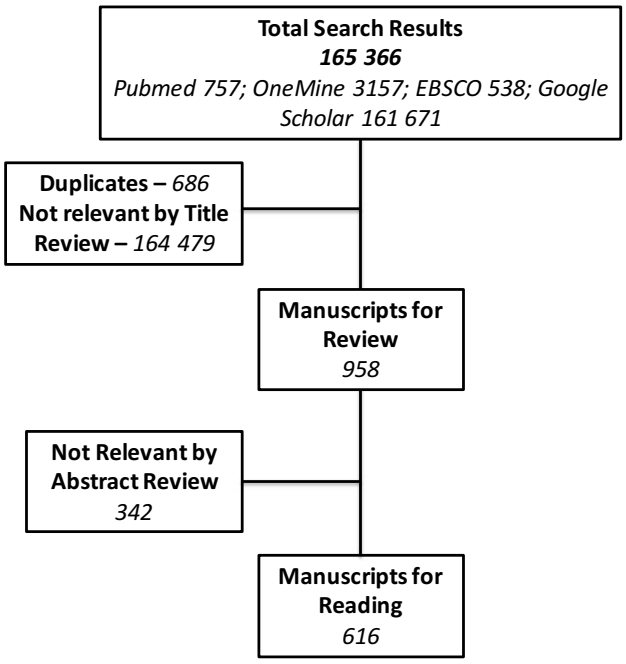
	BW	LS	MI	MZ	NA	SA	SZ	TZ	ZM	ZW	Southern Africa	To be reviewed	Total
Number of Articles	19	25	29	14	6	309	10	44	25	26	80	47	616
HIV	13	16	16	8	4	254	8	23	14	16	58	12	428
TB	9	16	21	7	1	177	7	19	12	12	40	13	321
Silicosis	2	18	1	0	0	96	0	6	4	4	10	7	147
Current miners	2	1	1	4	1	124	0	15	4	3	27	9	285
Ex-miners	2	6	0	1	0	34	1	0	1	0	9	1	55
Mining Communities	3	1	0	0	0	25	0	6	0	0	4	2	41
General Population	17	18	25	8	4	60	8	24	18	22	41	8	241
ASM	0	0	1	0	0	1	1	5	0	0	2	0	10
Gold	2	7	1	0	1	169	0	8	1	0	21	7	211
Coal	0	0	0	0	0	15	0	2	0	1	3	0	21
Quarrying	0	0	0	0	0	1	0	0	0	0	1	0	2
Other	2	0	1	1	2	24	0	3	0	1	5	1	40
Disease Compensation	0	1	1	1	0	27	0	1	0	0	1	0	32
Health and Safety	0	0	2	1	0	23	0	4	3	0	5	3	40
Legislation	1	1	1	0	1	7	0	4	0	1	7	0	23

A simplified version of the screening form was created in Excel and the remaining abstracts were captured. The topics of the abstracts are summarized in Table 2.2. Most of the articles reported on South Africa and focused on HIV. There was more published literature available on current miners compared to ex-miners, with a stronger focus on the gold mining industry compared to other commodities. There was little published data on Artisanal and small-scale mining across all 10 countries.

Citation Check

All papers in the master list were printed and sorted into country-specific files to create a library. The search team was again divided into four groups and were allocated countries to conduct the citation check. Citations from papers published between 2005 and 2016 were hand searched to find other relevant publications that might have been missed (Figure 2.6). All new manuscripts went through the same screening procedure and duplicates were removed (Figure 2.5). Through this process of citation checking, an additional 316 manuscripts were added to the master list. At the end of the selection process 950 publications were available in the library for review, most of which were from South Africa (Table 2.3).

■ Figure 2.5
Systematic Literature review manuscript output



■ Table 2.3 Final Master List

Country	Articles
Bostwana	26
Lesotho	46
Malawi	58
Mozambique	20
Namibia	7
South Africa	449
Swaziland	16
Tanzania	71
Zambia	32
Zimbabwe	38
Not specified	46
All countries	141
Total	980

Data Extraction

Three data collection forms were developed to gather information across several indicators: HIV prevalence, TB incidence, proportion of MDR-TB and mining population (Annexures 2-4). The three forms were designed to collect information stratified across country and district and where possible sub-district level. Study teams were allocated specific countries and were required to review and extract relevant data in order to complete the data collection tools. An online database was developed using REDCap[3] and all completed forms were captured.

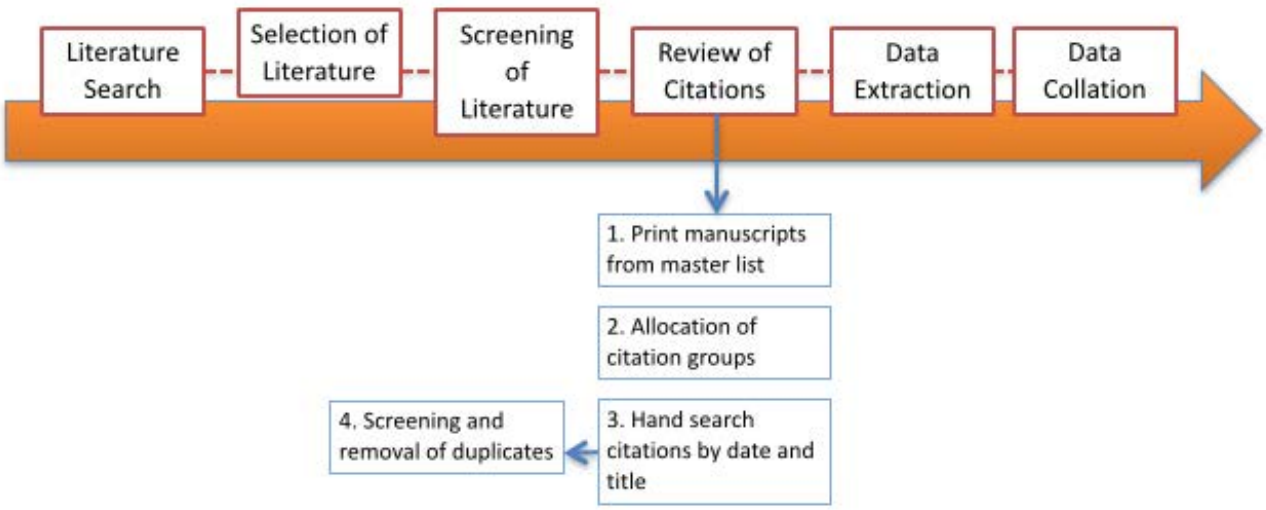
Data Collation

The literature review provided some country-level, and in rare cases district-level, prevalence and incidence rates of HIV, TB and silicosis. Univariate analysis such as descriptive statistics, frequencies, medians and proportions, were used to summarise this information. Furthermore, graphs and tables were generated to visually display country data. Some of the data collected during the literature review was used to inform the calculation of the baseline indicators.

Baseline indicators were calculated for the general population and mining population and were stratified by country and district. The World Health Organization,

■ Figure 2.6

Citation check process



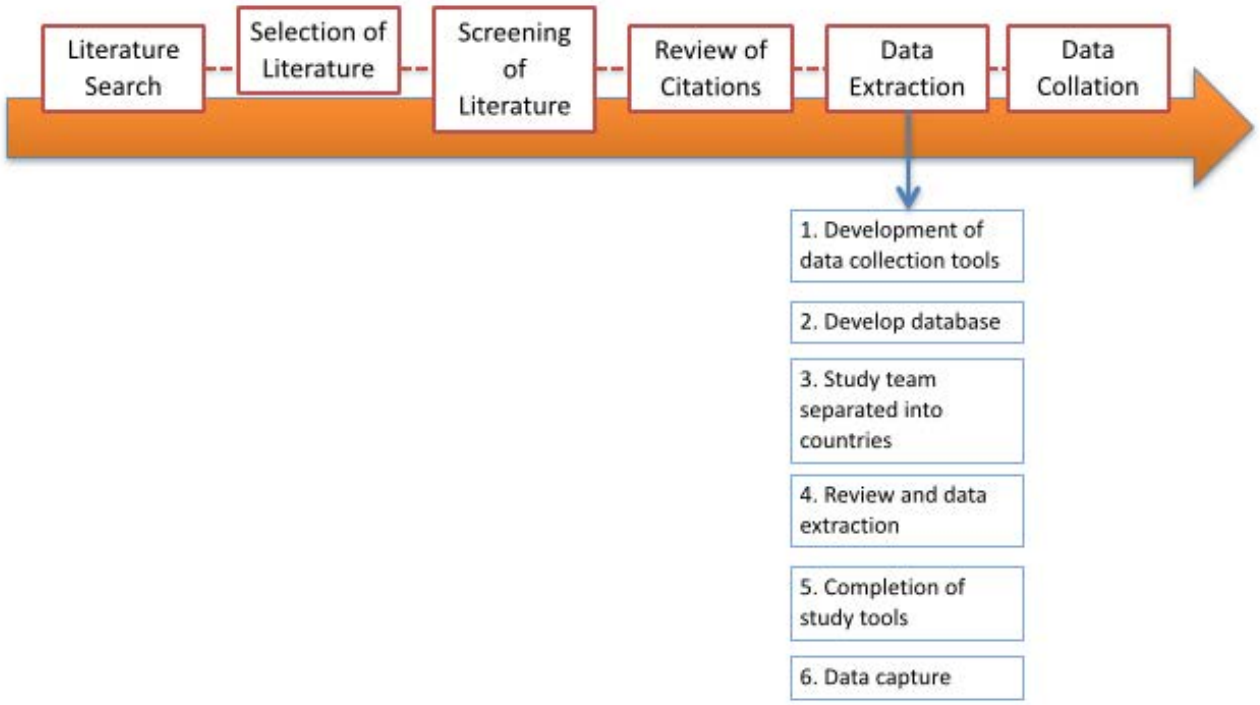
Global Tuberculosis Report was used to inform the country specific indicators (TB incidence and number of cases)[4]. Where incidence information was not available a formula was used to calculate it:

$$Incidence = \frac{Cases}{Population}$$

Calculated indicators are summarised in Table 2.4.

The final list of baseline indicators were colour coded to show those that were extracted from existing reports (black), those inferred from provincial or country level rates (blue), and those that were calculated (red) (Figure 2.8).

■ **Figure 2.7**
Data Extraction processes



■ **Figure 2.8 Baseline indicator colour codes**

Black text = Reported data	Red text = Calculated estimate	Blue text = inferred provincial or country level rate

■ **Table 2.4 Example of Baseline indicators from the WHO TB Report**

BASELINE INDICATORS
Population sizes
General Incidence
TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)
TB O-3: Proportion of estimated number of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)
TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed + clinically diagnosed) N=cases
MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB , N=Cases
TB/HIV-1: Proportion of TB patients with known HIV status (%)
TB/HIV-2: Proportion of HIV-Positive TB patients (%)
TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)
HIV Prevalence (Overall) (%)

Key Informant Interviews

Following the systematic literature review, a designated team of four people were required to develop a list of key informants, per country. The list contained information on the organisation the individual represented, their country and their contact information (telephone numbers or email address). The objective of interviewing key informants was to gather additional information, data and reports that might not be in the public domain. Key informants were classified as individuals working in mining: such as senior employees working at the Chambers of Mines in the countries of interest, mine health management teams, occupational health practitioners, pulmonologists and internists working at secondary and tertiary hospitals in areas that serve mining communities, union and workers' occupational health and safety representatives, pathologists, NGOs and academics and researchers working in this field.

The study aim was to conduct 20 key informant interviews per country. However, in some countries country-specific procedures made recruiting participants difficult. A structured interview guide comprising both closed-ended and open-ended questions was developed. The interview guide was divided into six sections and included questions designed to gauge participants' perceptions about the in-country mining landscape, changes in the industry, primary commodities, health services available and those provided to miners, ex-miners, their families and communities for HIV, TB and silicosis. Furthermore, the interview guide asked questions about mining legislation and occupational health facilitaties. They were also asked to contextualise their specific mining environments, noting changes in the size of the sector and subsequent change in the mining communities both local and those that have traditionally been labour-sending areas. Participants were instructed to answer as many questions as possible. Key informants were also asked to share with us, or direct us to, any other published or unpublished materials that might have been missed during the literature review or was not available to the public. Participants were also asked to recommend additional people within their countries who work in mining to be interviewed. The names of the recommended individuals were added to the list of key informants and contacted.

Potential key informants were first contacted via an email which outlined the aims and objectives of the study, their proposed role, institutions involved and different methods of conducting the interview. If there was no response a follow-up email was sent. In cases where possible, potential participants were contacted telephonically and meeting times were scheduled for interviews. Interested participants were given the option of answering the questions using any of four options: face-to-face interviews, telephonic/skype interviews, online survey or email. A total of 293 participants across all 10 countries were contacted and invited to take part in the key informant interviews (Table 2.5).

■ **Table 2.5 Number of approached and declined informants**

Country	Number of Approached Informants	Declined/Ineligible Informants	Number of Conducted Interviews
Botswana	20	8	12
Lesotho	62	48	14
South Africa	35	23	12
Swaziland	24	9	15
Tanzania	55	41	20
Namibia	45	34	11
Zambia	54	40	14
Malawi	Not Available		21
Mozambique	Human Research Ethics application declined		
Zimbabwe	Human Research Ethics application declined		
Total	**295**	**203**	**119**

Of those invited to participate 119 agreed to take part in the study. All participants had to sign a consent form before the interview was conducted. The study team also travelled to designated countries to conduct interviews with key informants in person. In some cases in-county collaborations were established to assist with the interview process. The highest number of interviews were conducted in Malawi (21) followed by Swaziland (15) and then Zambia (14). The majority of key informants represented the Departments of Health (39) and mining industry (18) (Table 2.6). A database was developed and all key informant interviews were captured electronically.

■ **Table 2.6 Interviewed Key informants by sector and country**

	BW	LS	MI	MZ	NA	SA	SZ	TZ	ZM	ZW	Total
Mine Healthcare	1							2	6		9
Occupational Medical Practice	1	1	1			1		1	2		7
Chamber of mines	1					1					2
Research/ Academia					2	1	1	1			5
Labour/Union	1		1		1		1		1		5
Department of Health	4	4	6		4	6	9	2	3		38
Department of Labour	1	1					1				3
Department of Mineral Resources	2	1	1		1						5
Mining Industry	1	1	9		1			5			17
ASM Sector					1			4			5
Compensation fund								1			1
Insurance Industry								1			1
International Health and Development Org. (WHO, MSF, ILO)		1				2	3	1	2		9
Other		5	3		1	1		2			12
Total	12	14	21		11	12	15	20	14		119

Data Analysis

Key Informant interviews were analysed by country using modified Braun and Clarke's steps of thematic analysis[5]. The first step required that the team immerse themselves into the data thus familiarising themselves with the collected information by re-reading all country specific interviews. Once the team was familiar with the content they searched for themes, extracted them and reviewed them. Study themes were guided by the overall study objective. Identified themes were named and defined. Key informant interview analysis has been included as a sub-section per country chapter outlining personal views of the mining and health landscape per country.

Unpublished Sources

PhD theses, Masters research reports, conference presentations and consultancy studies reporting health of mine workers and mining communities were searched for, using university databases, personal communications with stakeholders within each of the 10 countries, and searchable conference abstracts. We also reviewed reports from the mining industry and occupational health services. Other institutions that were contacted for annual and other official communications included: mining industry organisations such as the Chamber of Mines, and the National Institute for Occupational Health, statutory advisory and regulatory bodies such as the South African Mine and Health and Safety Council,

and government's Mine Health and Safety Inspectorate, Medical Bureau for Occupational Diseases, the Compensation Commission and Mine Insurance Industry. Through the key informant interviews we were also able to collect reports that were published but not available to the general public. All unpublished resources were first screened by the study team to ensure relevance to the study aims and objectives. If considered appropriate the study Principal Investigator would review the unpublished source.

Data Capture

REDCap[3] is a secure on-line application system that allows for the development of surveys and databases, the capture of information, and the management and exportation into numerous statistical programs[3]. The system is accessible from any location with internet connectivity. Captured data was protected by a user password and only select study staff members were given access to the databases. Furthermore, the server on which the data was captured had several back-up systems. REDCap was administered by the University of the Witwatersrand, Faculty of Health Sciences, and was managed by the PHRU data manager. A study member was tasked with ensuring that all extracted data from the data collection forms was captured correctly into REDCap. Each form was given a unique study-specific identification number.

References

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Botswana relies heavily on diamond exports. However, the index of mining production has reduced over the years with specifically diamond production decreasing for six consecutive years.

Chapter 3: **Botswana**

Executive Summary

Background: Botswana is a Southern African country with a population of 2 million people. The country is highly reliant on minerals (diamonds, copper, silver, iron ore and uranium) for income. The mining and quarrying industry contributes around a quarter of the GDP. There are 80 registered mines in Botswana, but mining and quarrying employs only 3% of the total number of employed people.

Key Findings: TB is the third leading cause of death for all age groups with the highest rates reported in miners, prisoners and refugees. The national TB incidence was estimated at 385 per 100 000 in 2014, a reduction compared to the high (623 per 100 000) levels reported in 2002 at the peak of the HIV epidemic. The proportion of MDR-TB cases among newly diagnosed TB patients is 2.5%. The general populations HIV prevalence is 18.5% whilst in the mining areas the HIV prevalence is over 24%. Antiretroviral treatment has increased over the years, with more than 200 000 people accessing treatment in 2013. In general, TB cases among miners have declined over the years however mining areas had TB rates that were higher than the national average in 2013 and 2014. Mining areas have the highest rates of HIV in the country with prevalence reaching 24% in some regions. Published literature on miners' health has described pneumoconiosis prevalence in ex-miners as high at 10% (31/304).

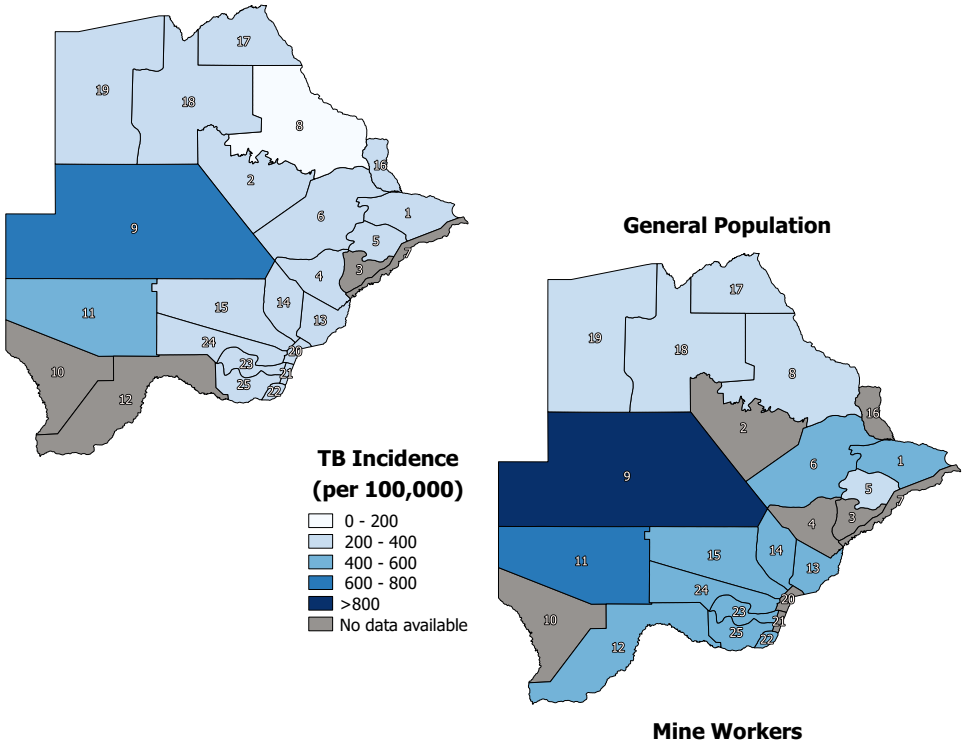
Limitations: There is limited and incomplete available data with regards to prevalence of TB, HIV and silicosis in the mines and mining districts of Botswana.

Recommendations: Occupational Health Services for miners and ex-miners need to be prioritised. Mineworkers need to be educated on occupational diseases as well as on compensation available to them. Collaboration between government and mining industries is essential to improve capacity in the diagnosis and management of silicosis.

Figure 3.1

TB incidence in general population and estimated TB incidence in mine workers in Botswana

ID	Name
1	Bobonong
2	Orapa
3	Machaneng
4	Mahalapye
5	Palapye
6	Serowe
7	Tuli
8	Tutume
9	Ghanzi
10	Gemsbok
11	Kgalagadi North
12	Kgalagadi South
13	Kgatleng
14	Kweneng East
15	Kweneng West
16	North East
17	Chobe
18	Ngamiland East
19	Ngamiland West
20	Gaborone
21	South East
22	Barolong
23	Ngwaketse Central
24	Ngwaketse North
25	Ngwaketse South



Introduction

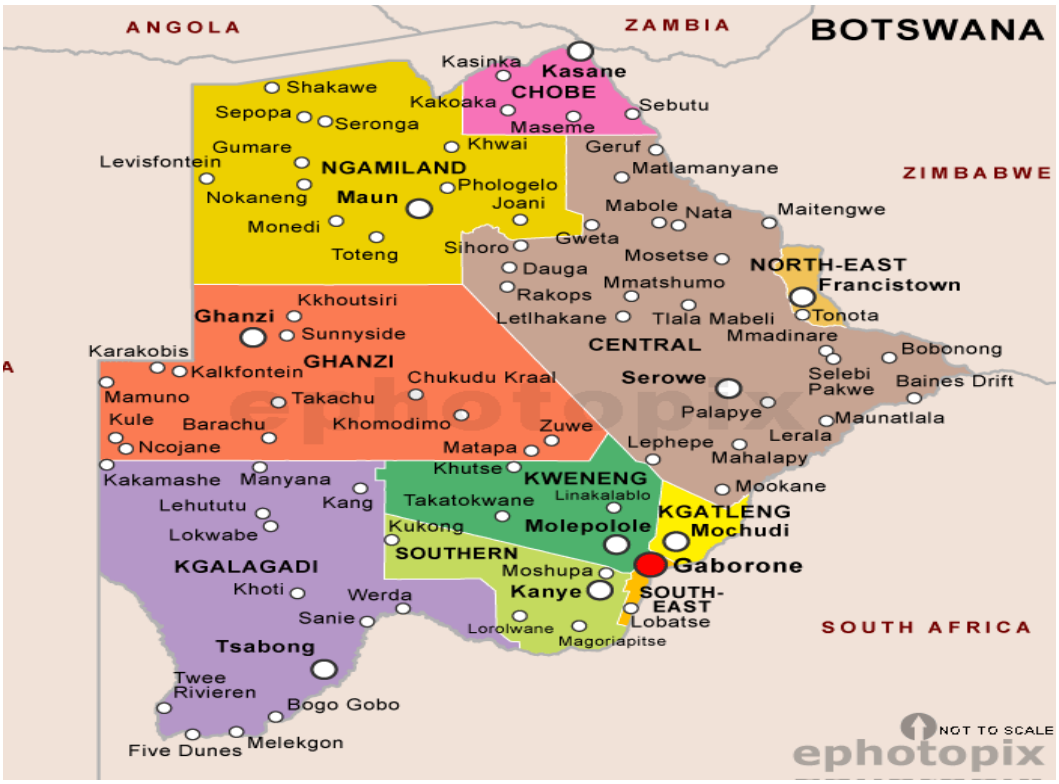
Botswana is a landlocked country in southern Africa, surrounded by South Africa to the south and southeast, Namibia to the north and west and Zimbabwe and Zambia to the northeast (Figure 3.2). The administrative capital is Gaborone, and Botswana has 16 districts (nine rural and seven urban) these are further sub-divided into sub-districts (Table 3.2)[1]. The overall population per the 2011 national census was 2 024 904[1]; the 2016 population is estimated to be 2,3-million with an almost equal gender split[2]. Most of Botswana's population is between 15 and 64 years (62,2%) and 33,9% of the population is under 15 years[2]. Botswana is classified as an upper-middle income country, with a GDP per capita of $12 350[2]. Unemployment is 17,8%, which has led to high-income inequality [3]. The poverty incidence of Botswana is 19,3%, however; in certain areas poverty remains extremely high[4]. The government relies on two revenue streams: minerals (40%) and customs (27%)[3]. Setswana is the national language and English is the official language.

General health indicators

The country spends 5,4% of GDP in total on health[5]. The male and female life expectancy at birth is 58,8 and 57,3 years respectively[2]. The overall birth rate is estimated to be 21,0 births/1 000 and the death rate is 13,4 deaths/1 000[5]. The rate of infant deaths is 8,9 deaths/1 000 populations and the maternal mortality rate is 129 deaths/100 000 population[5]. The major causes of mortality in infants and children under five years are: pneumonia, septicemia, diarrhea and other specified non-effective gastroenteritis, malnutrition among others[6]. The main causes of death for all ages are pneumonia, septicemia and tuberculosis (Figure 3.3)[6].

Botswana has 35 hospitals, 289 clinics and 900 mobile stops (no fixed structure managed by a nurse and a counselor) (Table 3.2)[7]. The density of physician and nurses per 100 000 is 4,3 and 41,3 respectively[8] with considerably more healthcare workers residing in urban than rural areas.

■ Figure 3.2
Map of Botswana



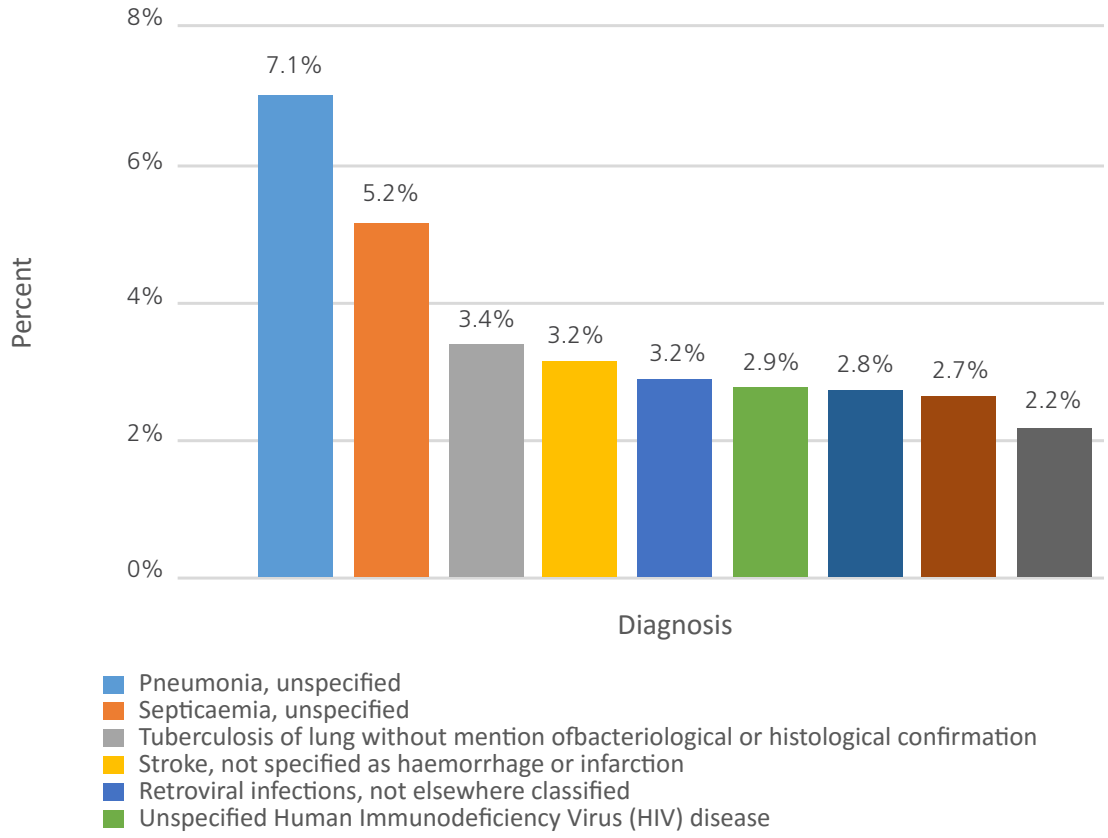
Mining landscape

Botswana's natural resources are scattered across the country and include: diamonds, copper, nickel, coal, soda ash, iron ore and silver. In 2013, mining contributed 24,5% to the national GDP[9]. Botswana relies heavily on diamond exports. However, the index of mining production has reduced over the years with specifically diamond production decreasing for six consecutive years[10]. Currently around 80 mines are registered in Botswana with coal and uranium production predicted to increase[11]. The mining and quarrying industry in Botswana, although large, only employs around 3,1% (12 377/391 536) of employees (Table 3.3)[12]. Botswana's mining and quarrying sectors also employ non-citizens[12].

■ **Figure 3.3**

Percentage distribution of major causes of mortality for all ages

[Available from http://www.cso.gov.bw/index.php/summary-statistics/255-causes-of-mortality-2012]



■ **Table 3.1** Distribution of population by district and locality type

District	Cities/Town	Urban Villages	Urban	Rural	Total
Gaborone	231 592	0	231 592	0	231 592
Francistown	98 961	0	98 961	0	98 961
Lobatse	29 007	0	29 007	0	29 007
Selebi-Phikwe	49 411	0	49 411	0	49 411
Orapa	9 531	0	9 531	0	9 531
Jwaneng	18 008	0	18 008	0	18 008
Sowa Town	3 598	0	3 598	0	3 598
Southern	0	0	101 608	96 159	197 767
Ngwaketse	0	78 846	78 846	50 401	129 247
Barolong	0	11 439	11 439	43 392	54 831
Ngwaketse West	0	11 323	11 323	2 366	13 689
South East	0	72 915	72 915	12 099	85 014
Kweneng	0	214 496	214 496	90 053	304 549
Kweneng East	0	207 252	207 252	49 500	256 752
Kweneng West	0	7 244	7 244	40 553	47 797
Kgatleng	0	56 170	56 170	35 490	91 680
Central	0	276 417	276 417	299 647	576 064
Central Serowe Palapye	0	94 945	94 945	85 555	180 500
Central Mahalapye	0	52 977	52 977	65 898	110 875
Central Bobonong	0	37 537	37 537	34 399	71 936
Central Boteti	0	29 307	29 307	28 069	57 376
Central Tutume	0	61 651	61 651	65 726	147 377
North East	0	13 778	13 778	46 486	60 264
North West	0	85 150	85 150	90 473	175 631
Ngamiland East	0	60 257	60 257	30 077	90 334
Ngamiland West	0	15 225	15 225	44 196	59 421
Chobe	0	9 008	9 008	14 339	23 347
Okavango Delta	0	668	668	1 861	2 529
Ghanzi	0	14 809	14 809	20 546	
Ghanzi	0	14 809	14 809	20 206	43 095
Central Kgalagadi Game Reserve (CKGR)	0	0	0	260	206
Kgalagadi	0	21 028	21 828	28 664	50 492
Kgalagadi South	0	8 921	8 921	21 095	30 016
Kgalagadi North	0	12 907	12 907	7 569	
Total	**440 100**	**1 297 207**	**1 297 287**	**727,617**	**2 024,904**

[Available from Botswana Health Facilities]

■ Table 3.2 Health facilities by type and district, 2012

District	Referral Hospital	General Hospital	Primary Hospital	Clinics		Total Clinics	Health Post		Total H/ Posts	Total H/ Facilities	Mobile Stops
				With beds	No beds		With Nurse	No Nurse			
Ngamiland		2		6	8	14	19	1	20	36	73
North East			1	5	7	12	25		25	38	12
Palapye			1	4	7	11	22		22	34	24
Bobirwa			2	6	2	8	13		13	23	22
Kweneng East		2	1	4	14	18	20	1	21	42	42
Southern (Kanye)		1		1	6	7	6	4	10	18	
Gantsi			1	1	2	3	10		10	14	352
Mahalapye		1	1	5	10	15	28		28	45	27
Kgatleng		1		5	9	14	14	2	16	31	33
Chobe			1	2	1	3	12		12	16	2
Kgalagadi-South			1	5	1	6	16		16	23	14
Tutume			2	7	5	12	18		18	32	21
Boteti		1	2	2	10	12	12		12	27	66
Okavango			1	7	4	11	15	2	17	29	30
Gaborone	1	1		7	30	37	5		5	44	13
Francistown	1			8	17	25	12	1	13	39	19
South East		1		2	5	7	2		2	10	36
Lobatse	1	1		3	7	10	1		1	13	4
S/Phikwe		2		3	8	11				13	
Kweneng West			1	4	4	8	16		16	25	26
Mabutsane				2	2	4	5		5	9	3
Jwaneng		1		2	5	7	5		5	13	12
Good Hope			1	4	6	10	25		25	36	14
Kgalagadi North			1	2		2	12	1	13	16	3
Moshupa Sub				4	2	6	11		11	17	13
Charles Hill				3	2	5	4	1	5	10	10
Serowe		1		4	7	11	9		9	21	29
Grand Total	**3**	**15**	**17**	**108**	**181**	**289**	**337**	**13**	**350**	**674**	**900**

[Available from Botswana Health Facilities]

■ Table 3.3 Estimated Number of paid employees by economic activity, citizenship and sex from September 2014 to September 2015

Sector/ Economic Activity	September 2015									Sept 2014	%
	Citizens			Non-Citizens			All Employees			Total	Change
	Male	Female	Total	Male	Female	Total	Male	Female	Total		
Agriculture	3 451	2 823	6 274	264	99	363	3 715	2 922	6 637	6 514	1,9
Mining and Quarrying	10 738	1 639	12 377	374	22	396	11 112	1 661	12 773	12 547	1,8
Manufacturing	21 424	13 866	35 89	1 640	387	2 027	23 064	14 253	37 316	37 047	0,7
Electricity & Water	3 426	1 319	4 745	6	1	7	3 432	1 320	4 752	4 692	1,3
Construction	17 234	3 813	21 047	1 654	176	1 830	18 888	3 989	22 877	23 632	-3,2
Wholesale & Retail Trade	25 165	22 239	47 404	1 370	132	1 502	26 535	22 371	48 906	48 723	0,4
Hotels & Restaurants	6 797	10 444	17 241	478	175	653	7 275	10 619	17 894	17 778	0,7
Transport & Communication	7 212	5 491	12 704	534	218	753	7 746	5 709	13 457	13 357	0,7
Finance	3 206	5 702	8 908	135	39	174	3 341	5 741	9 082	9 013	0,8
Real Estate	13 974	5 232	19 206	243	68	310	14 217	5 300	19 516	19 277	1,2
Education	3 569	4 681	8 250	1 046	886	1 931	4 615	5 567	10 181	10 270	-0,9
Health	723	1 959	2 682	165	284	449	888	2 243	3 131	3 125	0,2
Other Community	1 505	2 754	4 260	80	33	113	1 585	2 787	4 373	4 214	3,8
Private and Parastatal	118 424	81 962	200 387	7 989	2 520	10 508	126 413	84 482	210 895	210 189	0,3
Private	107 399	74 049	181 449	7 599	2 437	10 035	114 998	76 486	191 484	191 399	-0,1
Parastatal	11 025	7 913	18 938	390	83	473	11 415	7 996	19 411	18 790	5,7
Central Government	48 032	54 856	102 888	975	486	1 461	49 007	55 342	104 349	104 317	0,03
Local Government	31 909	56 353	88 262	104	72	176	32 012	56 425	88 437	89 955	-1,7
Ipelegeng	19 396	43,170	62,566	-	-	-	19 396	43 170	62 566	64 354	-2,8
Local Gov. Excl. Ipelegeng	12 513	13 183	25 696	103,5	72	175,5	12 v616	13 255	25 871	25 601	1,1
All Sectors excl. Ipelegeng Programme employees	178 968	150 001	328 970	9 068	3 078	12 145	188 036	153 079	341 115	340 107	0,3
All Sectors	**198 365**	**193 171**	**391 536**	**9 068**	**3 078**	**12 145**	**207 432**	**196 249**	**403 681**	**404 461**	**-0,2**

[Available from Statistics Botswana]

Results

General Population: TB and HIV Epidemiology

In 2015 an estimated 350 000 [330 000-370 000] people in Botswana were living with HIV, with an overall country HIV prevalence of 18,5%[13,14]. Among those aged 15-49 years, HIV prevalence is 22,2%[13,14]. Although HIV prevalence has reduced, it remains the third highest in the world. Women are disproportionately affected, with an HIV prevalence of 19,2% compared to 14,1% in men[14]. In 2015 9 700[15] new HIV infections and 3 200 HIV/AIDS related deaths were reported[13]. A study was conducted in 2011 that recorded the antenatal HIV prevalence for first-time pregnant women as 19,9%[16].

The uptake of HIV testing has remained low in Botswana, with less than 70% of people in 2012 testing[17]. Efforts have been made to scale up testing, for example by providing voluntary testing services, and HIV testing at routine checkups. Botswana has struggled to maintain high use of condoms with reported numbers dropping from around 90% in 2008 to 81% in 2012[18]. Leading the way in prevention and treatment, Botswana was the first sub-Saharan country to offer universal free antiretroviral treatment to all people living with HIV. The country has had a successful PMTCT program where 95% of an estimated 11 000 HIV-infected pregnant women receive ART[14]. In 2013 an estimated 69% of adults and 84% of children living with HIV were receiving ART (Figure 3.4)[19]. In 2015 the coverage for adults increased to 78% and more than 95% for children[15] with more women than men accessing treatment. Research in rural communities has shown that 70,3% of people living with HIV had achieved viral suppression, close to the UNAIDS target of 73%[20].

■ **Figure 3.4**

Number of people accessing antiretroviral treatment in Botswana 2004-2013

Available from http://www.avert.org/professionals/hiv-around-world/sub-saharan-africa/botswana

■ **Table 3.4 Reported TB/ HIV Botswana 2014** *Available from WHO Botswana 2014 Tuberculosis profile.*

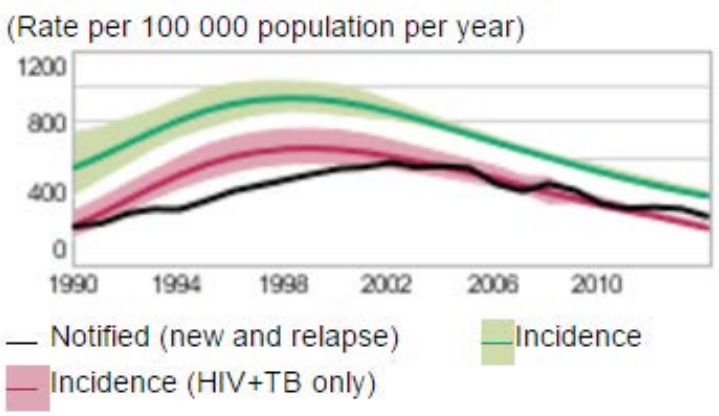
TB/HIV 2014	Number	(%)
TB patients with known HIV Status	5496	(91)
HIV-positive TB patients	3280	(60)
HIV-positive TB patients on co-trimoxazole preventive therapy (CPT)	3132	(95)
HIV-positive TB patients on antiretroviral theraphy (ART)	2546	(78)
HIV-positive people screened for TB		
HIV-positive people provided with IPT		

The overall incidence of TB in Botswana in 2014 was 385/100 000 with the incidence rate decreasing considerably over the years (Figure 3.5)[21]. In 2014, there were a total of 6 019 new and relapse TB cases of which around 7% were children (less than 15 years old)[21]. Sixty percent of TB patients were co-infected with HIV and 78% of these were on ART (Table 3.4)[21]. The HIV/TB mortality rate for Botswana is estimated to be 47/100 000[21]. It is projected that 2,5% of new TB cases and 6,6% of retreatment TB cases in Botswana have MDR-TB (Table 3.5)[21].

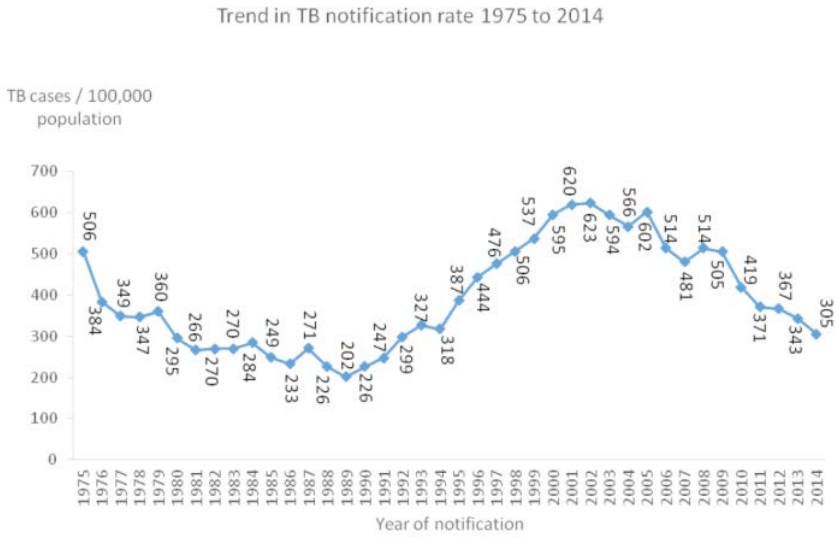
The TB epidemic in Botswana follows the HIV/AIDS epidemic, increasing steadily in the 1990's from 226 per 100 000 to a peak of 623 per 100 000 in 2002. Subsequently, the number has gradually declined, to 305 cases per 100 000 (6 542 cases) in 2014[21]. The trends in TB notification from 1975 to 2014 are summarised in Figure 3.6. Trends in MDR- TB are depicted in Figure 3.7[22].

Disaggregated by gender, the TB notification rate is higher in males than in females for all age groups in 2013 and 2014, except for individuals aged 15 to 24 years

■ **Figure 3.5**
Profile of TB in Botswana over the years
Available from WHO Botswana 2014 Tuberculosis profile



■ **Figure 3.6**
Trends in TB Notification rates Botswana 1975 – 2014[22]
Available from Botswana National TB Programme 2013 and 2014



■ **Table 3.5** **Reported MDR TB Botswana 2014** *Available from WHO Botswana 2014 Tuberculosis profile.*

Estimates of MDR-TB burdern 2014	New	Retreatment
% of TB cases with MDR-TB	2.5 (1.5-3.5)	6.6 (2.4-11)
MDR-TB cases among notified pulmonary TB cases	100 (61-140)	56(20-90)

old (Figure 3.8). In line with the HIV prevalence for Botswana, the age group mostly affected by TB is the 15-54 year-old group.

Similarly, there is a significant difference in TB notification rates by district within the country, with the highest rates for both 2013 and 2014 recorded in non-mining areas (Charles Hill, Moshupa, Gantsi, Tonota) though the mining areas (Jwaneng and Serowe) also have incidence above national average (Table 3.6). Tutune, Kanye (Southern), Borirwa, Palapye sub-district and Okovango had the lowest TB incidence for both years.

Figure 3.7

MDR-TB Notification Trend from 2007 to 2014

Available from Botswana National TB Programme 2013 and 2014

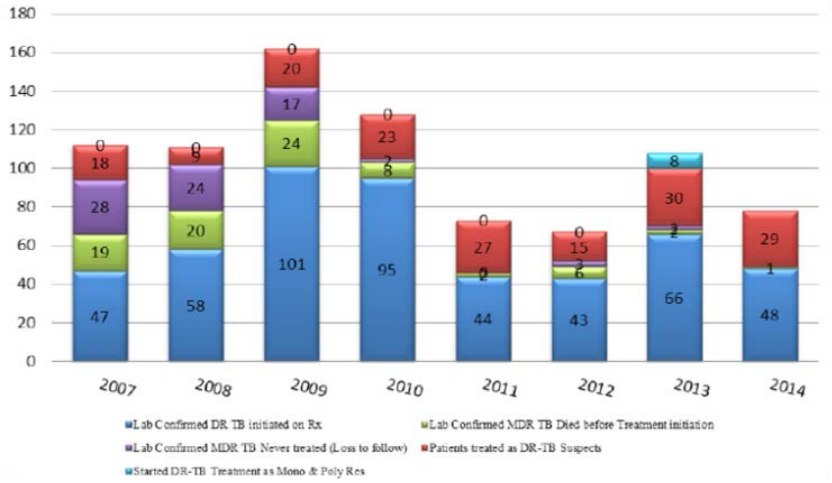
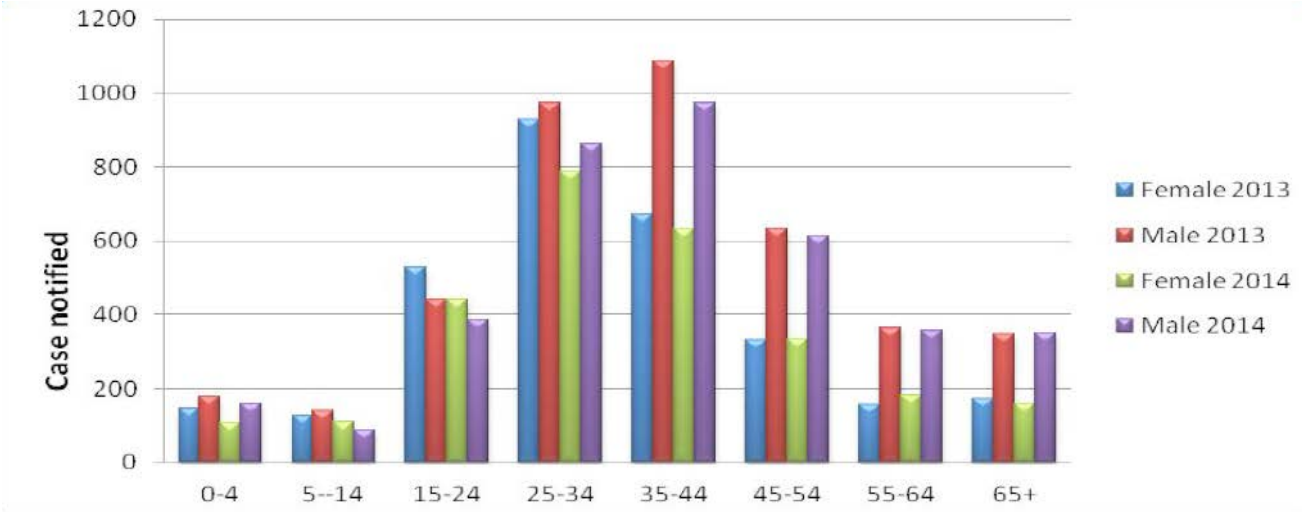


Figure 3.8

Overall TB case notification by age group and gender in 2013 (N=7220) and 2014 (N=6542)

Available from Botswana National TB Programme 2013 and 2014



■ Table 3.6 TB notification rates by district for 2013 and 2014

District	Notified TB Cases	Rates/ 100000	Notified TB Cases 2	Rates/ 100000 Pop
Charles hill	80	2145	90	2369
Moshupa Sub- District	243	1169	230	1 086
Gantsi	272	663	257	615
Tonota	187	856	135	607
Jwaneng	119	636	99	520
Kgalagadi North	109	513	112	517
Kgalagadi South	144	462	139	438
Mutsane	59	415	62	428
Kweneng East	1131	424	1 004	370
Serowe	329	370	335	369
Boteti	277	397	253	356
Lobatse	135	448	106	345
Kgatleng	356	374	323	333
Francistown	632	352	329	314
Goodhope	135	237	175	302
South East	322	365	272	302
Gaborone	728	303	697	284
Kweneng West	211	425	137	271
Ngamiland	249	265	255	267
Chobe	45	186	60	243
Mahlalapye	348	282	287	228
Selebi Phikwe	184	359	119	228
North East	163	260	142	223
Okavango	149	232	146	223
Palapye Sub District	242	246	223	222
Borirwa	193	258	149	196
Kanye (Southern)	189	167	189	164
Tutume	259	192	217	18
Grand total	**7 490**	**13 001**	**6 542**	**11 838**

Available from Botswana National TB Programme 2013 and 2014

Furthermore, special populations including miners, prisoner and refugees, have higher TB rates. In 2008, the TB incidences rate in Botswana's prisons was 1 430 per, 100 000, about 3-4 times higher than the general population rate of 305 100 000. Data from three mines is summarized in Figure 3.9. In general, TB cases among miners have declined over the years, with occasional spikes, (for example, in 2010 and 2013).

Treatment outcomes for smear-positive TB cases have improved over the years, from less than 75% for the period 2006 to 2008 to 95% in 2014 (Figure 3.10). In 2014, 78% of TB cases were successfully treated, 3% defaulted, 9% died, 1% failed treatment and 10% were not evaluated. These outcomes resemble those in 2013, (Table 3.7), and are like the treatment outcomes for MDR-TB (Table 3.6).

Figure 3.9

TB case notification among the 3 largest mines in Botswana (2007 to 2014)

Available from Botswana National TB Programme 2013 and 2014

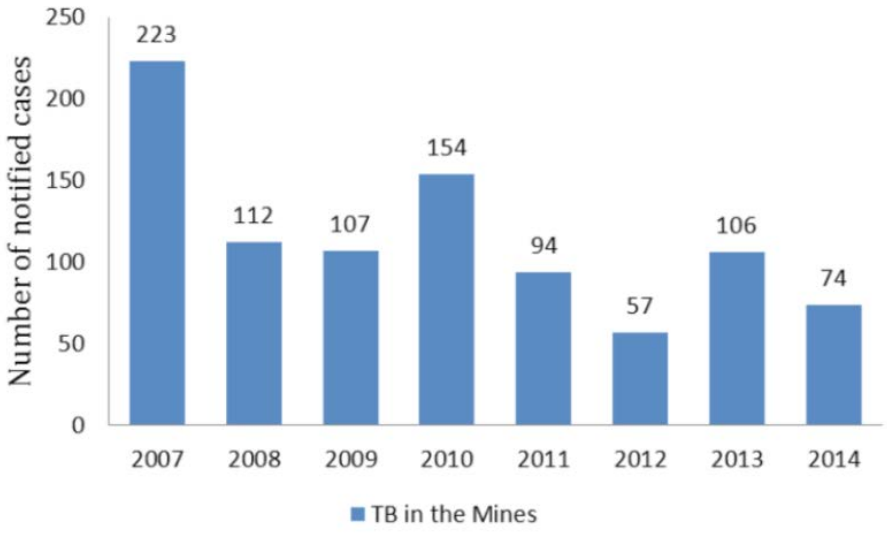
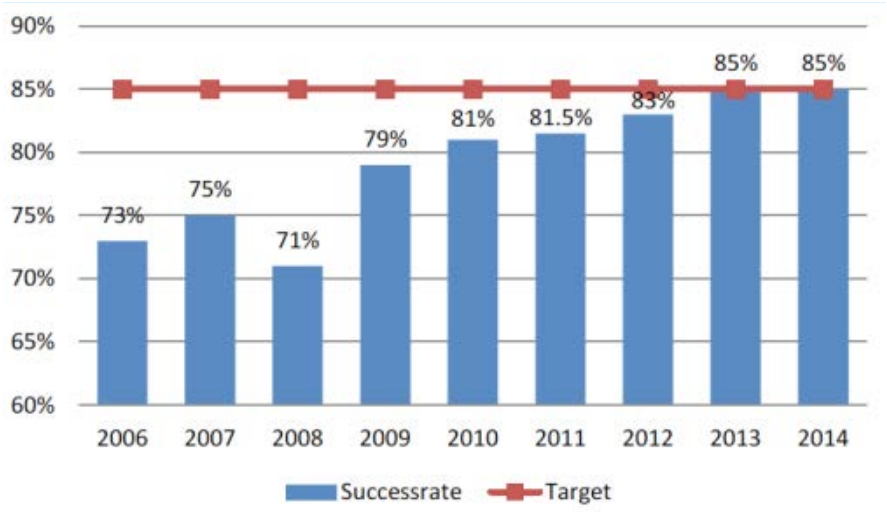


Figure 3.10

Treatment success trend in new smear positive TB Cases 2006 – 2014

Available from Botswana National TB Programme 2013 and 2014



Published Literature

As part of the secondary data review, existing research publications and reports for Botswana were identified, reviewed and summarized. We reviewed three research publications that covered the years 1997, 2011 and 2012. The commodities include: gold, platinum, copper, nickel, asbestos, diamond and chrome. The target populations for the studies included ex-miners employed in South Africa and peri-mining communities.

1. Kandana et al. (2012), conducted a study to investigate and explain district-level inequalities in HIV rates. The data for the studies were derived from a nationally representative demographic survey conducted by the Botswana Central Statistical Office and funded by the Government of Botswana[23]. The district with the highest HIV prevalence was Selebi Phikwe 143 (27,6%) followed by Sowa 18 (25%) (Figure 3.11). The districts Selebi Phikwe and Sowa are both mining towns and there is evidence that increased prevalence of STIs and low condom use in mining communities increases the spread of the virus. In conclusion, the study showed a clear geographical distribution of the HIV epidemic, with the highest prevalence in the east-central districts.

2. Ekosse (2011), conducted a study looking at the health status of residents close to a nickel-copper mine/concentrator smelter plants in Botswana[24]. Questionnaires collecting demographic data, family history, health information, medical history, information about current treatment and social and

■ **Table 3.7 Botswana Treatment Outcomes *[Figures rounded, may not add up to 100%**

All Forms of TB				
Treatment Outcome	**2013**		**2014**	
	N	%	N	%
Completed	4 449	62	3 825	59
Cured	1278	18	1224	19
Default	201	3	200	3
Died	584	8	576	9
Failed	84	1	80	1
Not Evaluated	624	9	637	10
Grand Total	**7 220**	**100***	**6 542**	**100**

Available from Botswana National Programme Reports

■ **Table 3.8 Treatment outcomes for MDR-TB in Botswana**

Indicators	2008	2009	2010	2011	2012	2013	Total
Complete (%)	41	59	71	42	34	57	304
Cured N (%)	20	53	26	8	10	16	133
Success N (%)	61(65%)	112(73.2%)	97(75.8%)	50(74.6%)	44(69.8%)	73(70.2%)	437
Deceased N (%)	18(19.1%)	30(19.6%)	28(21.9%)	15(22.4%)	12(19.0%)	13(12.5%)	116
Defaulted N (%)	6(6.4%)	7(4.6%)	2(1.6%)	0	1(1.6%)	2(1.9%)	18
Failure N (%)	3(3.2%)	1(0.7%)	1(0.8%)	1(1.5%)	3(4.8%)	2(1.9%)	11
Not Evaluted N (%)	6(6.4%)	3(2%)	0	1(1.5%)	3(4.8%)	14(13.5%)	26
Grand Total N (%)	**94(100%)**	**153**	**128**	**67**	**63**	**104**	**609**

Available from Botswana National Programme Reports

personal indicators were distributed to 600 copper and nickel peri-mining community members. Survey respondents complained of palpitations, pains in the lower abdomen, shortness of breath and chest pain, coughing regularly and frequent headaches. The study concluded that health complaints from community members could be linked to environmental pollution associated with mining activities and that health hazards increased with proximity to mines[24]. It was recommended that government and affiliated institutions should monitor pollution activities around the mines.

i) Steen et al. (1997), conducted a cross-sectional survey to investigate the prevalence of occupational lung disease among 304 Batswana men formally employed in the South African mining industry. The study population was ex-miners from the Kwenge District who had worked in South Africa across multiple commodities: gold 85,5%, platinum 12,8% and asbestos/diamonds/chrome/quarry<1%[25]. The mean age of the ex-miners was 56,7 years with a mean duration of 15,5 years of service in the mines, and 46,8% reported being unemployed at the time of the study. Of the participants 26,6% had a history of TB (13,2/1 000) and 23,3% had experienced a disabling occupational injury[25]. Thirty-one of the 304 (10,2%) had pneumoconiosis, with the odds of contracting pneumoconiosis being three times higher if the participant had TB compared to no TB. The study justified the need to screen former miners in Botswana and elsewhere and identified a failure of measures to identify and prevent pneumoconiosis.

Perceptions of Key Informants

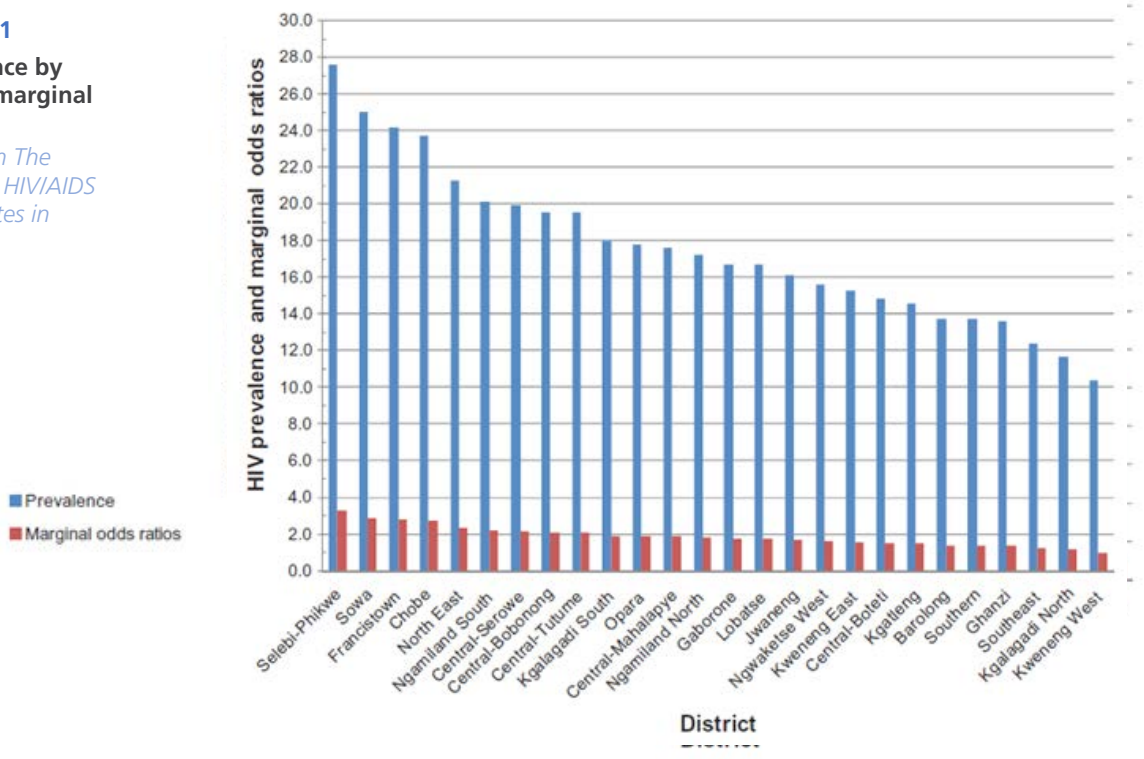
Population Description

Twelve key informants from Botswana were interviewed: 10 from Gaborone, one from Jwaneng and one from Selebi Phikwe region. The median age of the key informants was 42 years (IQR: 35-57 years). They were from different sectors and departments: Department of Health (4), Department of Labour (2), Mining Sector (2), Compensation Funds (2), Chamber of Mines (1) and the private health sector (1). The informants' roles at the time of interview are summarised in Figure 3.12. The median duration in those roles was 5 years (IQR: 4-9 years). Data collected from the key informants indicates perceptions and knowledge about the mining activities in their country and TB, HIV and silicosis among miners, ex-miners and their communities. Botswana did not capture employment history (miners and ex-miners) data previously on its health system records; government has only recently started collecting this data.

■ **Figure 3.11**

HIV prevalence by district and marginal odds ratio

Available from The geography of HIV/AIDS prevalence rates in Botswana



■ **Table 3.9 Summary of Botswana Research Publications**

Reference	District	Population	Commod-ities	Method	Prevalence and Incidence	Comments
Steen et al. Prevalence Of occupational lung disease in the South African mining industry. Occupational and Environmental Medicine, 1997;54:19-26.	**Kweneng District**	Ex-miners who worked in South Africa	85.5% were Gold miners, 12.8% platinum, <1% asbestos/ diamonds/ chrome/ quarry	Cross-sectional Survey	**PREVALENCE Pneumoconiosis:** 31/304 - strongest predictor for pneumoconiosis was previous TB. Odd of contracting Pneumoconiosis were 3 times higher if you had previous TB compared to no TB. **INCIDENCE TB:** 13.2/1000	1008/14400 were ex-miners in Thamaga village (7% of the population). Article justifies need to screen former miners. Indicates a failure of measures to identify or prevent pneumoconiosis while the miners were employed. Inadequate compensation of ex-miners
Ekosse G-IE. Health status within the precincts of a nickel-copper mining and smelting environment. African Health Sciences 2011, 11(1): 90-96	**Selebi Phikwe**	Peri-mining communities	Copper, Nickle	Survey		Community health hazards increased with proximity to the mines. Community members complained of chest pain. Government should monitor pollution in the mines.
Kandala et al. The geography of HIV/AIDS prevalence rates in Botswana. HIV/AIDS - Research and Palliative Care 2012:4 95–102	**Botswana**	Not specified		National Representative Demographic Survey	**HIV Prevalence 2008:** Gaborone 248 (16,7), Francis Town 169 (24,2), Lobatse 38(16,7), Selebi Phikwe 143(27,6), Orapa 13(17,8), Jwaneng 14(16,1), Sowa 18(25,0), Southern 140 (18,7), Barolong 64(18,7), Ngwaketse West 32(15,6), Southeast 56(12,4), Kweneng East 210(15,3), Kweneng West 32(10,4), Kgatleng 93(14,6), Central Serowe 276(19,9), | Central Mahalapye 184(17,6), Central Bobonong 112(19,5), Central Boteti 52(14,8), Central Tutume 187(19,5), Northeast 87(21,3), Ngamiland South 104(20,1), Ngamiland North 70(17,2), Chobe 52(23,7), Ghanzi 39(13,6), Kgalagadi South 62(18,0), Kgalagadi North 26(11,7)	The districts (Selebi Phikwe; Sowa) with the highest HIV prevalence are both mining towns. The study found evidence of increased prevalence of STIs and low condom use.

Mining

Most of the key informants were aware of mining activities in Botswana. A high proportion of participants reported diamond, magnesium, copper, and coal as the most commonly mined commodities (Figure 3.13).

Debswana Diamond Mine, BCL Limited, Tati Nickel and Morupule mines were reported as the top five mining companies in the country. Most mines were reported to be situated at Jwaneng, Selebi Phikwe and Francistown. Most of the informants reported surface mining to be the most active type of mining in Botswana followed by quarrying and underground mining. Only one informant mentioned dredging as another type of mining practised in Botswana (Figure 3.14).

Most informants were aware of available TB screening, prevention and treatment services offered to current miners, their communities and ex-miners (Table 3.15). They reported that miners are usually screened for general health at the start of employment. According to the informants, current miners access health services from the on-site mine occupational health services, while communities and ex-miners access health services from public health facilities and NGOs. Most informants did not include TB as an occupational disease, but regarded it as a communicable disease potentially acquired in any setting. Therefore, they reported, in Botswana, there is no compensation system for current miners diagnosed with TB. On the other hand, only three informants indicated that current miners are screened for MDR-TB. Most informants stated that no prevention and treatment for MDR-TB is offered by employers to miners working in Botswana. Similarly, while miners are screened for HIV, current miners are not offered any HIV prevention and treatment. However, two informants stated that medical male circumcision (MMC) is offered to current miners at some state hospitals. Lastly, few participants could discuss or report data on silicosis among current miners, with most indicating that they did not know much about silicosis in Botswana. One participant commented:

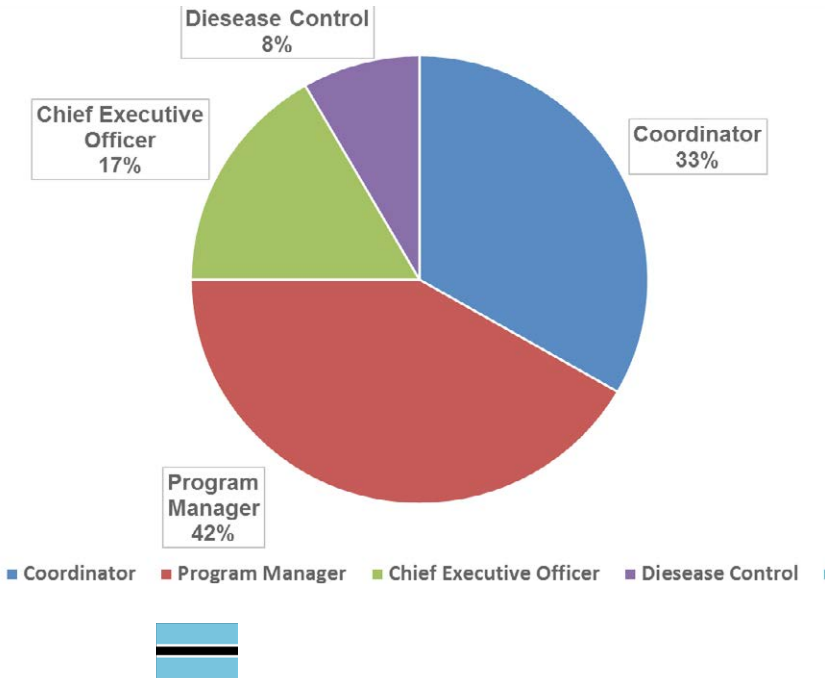
"We do not have much of silicosis, our mines don't have silica dust"
(KI035, Mining Industry)

"The Botswana health system and mine occupational clinic are much more familiar with what they refer to as "silica TB" rather than silicosis"
(KI039, Department of Health)

Ex-miners

Only a few informants described health services available to ex-miners. One informant stated, *"No services [are] provided specifically for the ex-miners"* (KI032, Department of Health). Other informants commented that ex-miners are treated like the general population. According to most of the informants, most ex-miners access health services through NGOs. Only two informants reported that ex-miners access health services elsewhere (public health and mine occupational health). Some informants mentioned that once the miners are no longer employed

■ **Figure 3.12**
Role of Botswana Key Informants at time of interview
Available from Botswana National Key Informants



by the mines, they have to pay for health services at the public hospitals and clinics as the system can no longer recognise them as active miners.

"Free treatment for all, there are free services only for mines but once outside they pay at the public hospital, clinic 'cause we cannot identify them"

(KI027, Department of Health)

Health system

Three out of six of the informants stated that the Botswana health system is adequate. The other informants commented that the system is inadequate because they have observed that it focuses only on pre-employment assessment. When a miner is in employment medical assessments are not done regularly. Some informants mentioned that the public hospitals do not have health specialists and some mine health facilities do not have TB coordinators. This limits the health system's effectiveness in increasing access to TB diagnosis and treatment. One informant noted that the public health system is not designed to address mining-related issues or mine occupational diseases but rather those of the general population: *"Health system general was not set up for the mining issues"* (KI029, Department of Health). Big mining companies seem to have hospitals and clinics that treat occupational health diseases, and some mine hospitals offer their services to families and communities of current miners.

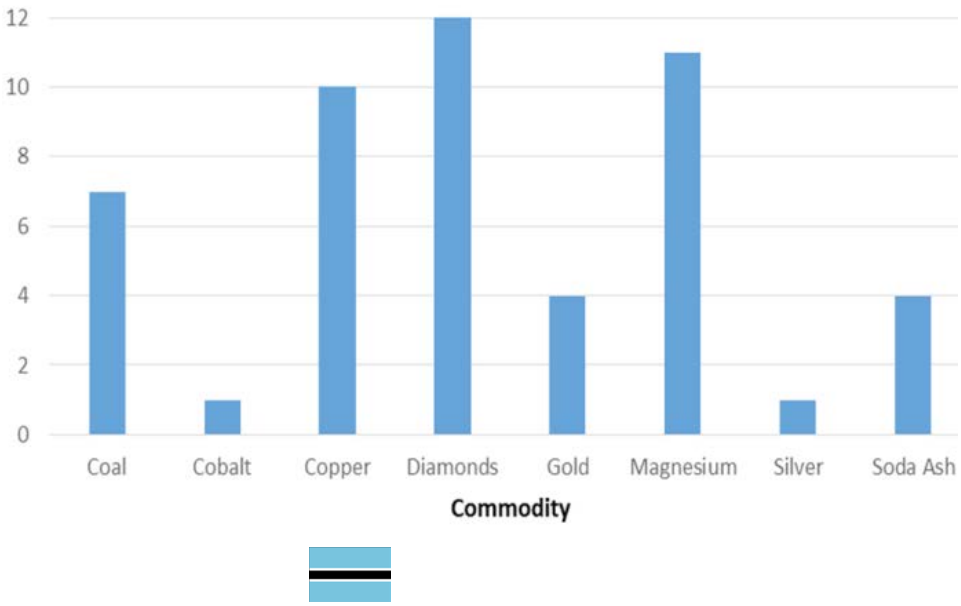
Most the informants reported that should a miner be declared by a doctor unfit to work due to illness, he is granted a maximum of two weeks paid leave in accordance with the Employment Act. Moreover, TB coordinators and volunteers have a duty to conduct contact tracing for close members of the miners or patients diagnosed with TB. Occasionally, nurses advise patients to bring along household members for them to be screened for TB. Additionally, should a miner get very sick and need to relocate, the hospital will issue a letter of referral to the miner to take to his new point of care. The spouse of a current miner accesses TB screening and treatment at the nearest point of care or state hospital.

Health and safety legislation

Most informants reported that Botswana does not have specific legislation on miners' health and safety. The legislation only refers to general health and safety procedures and safety equipment and clothing to be used by miners. One informant commented about the legislation "*just basic safety precautions, what to wear, like helmets, suits ……*" (KI054, Department of Labour).

Some informants stated that the legislation stipulates that all employees are to work in a safe working environment. One informant mentioned that the employer is responsible for employees' health and safety. Five of the informants reported that a compensation system for sick miners with occupational diseases exists in Botswana, while the rest said that they are not aware of any compensation system for miners. One informant suggested that the compensation is determined by the miner's inability to continue employment.

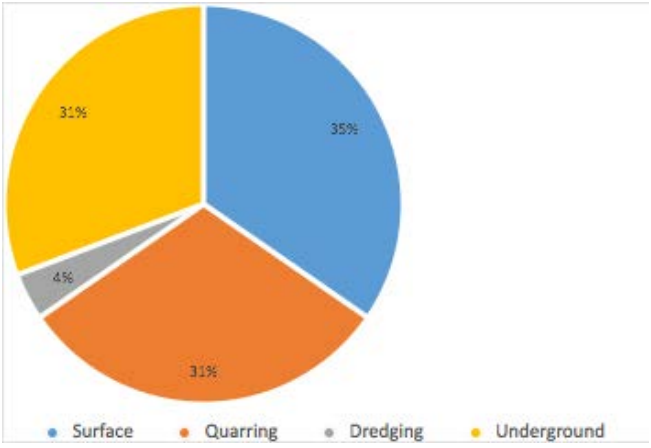
■ **Figure 3.13**
Mined commodities in Botswana
Available from Botswana Key Informants



■ **Figure 3.14**

Type of mining activities in Botswana

Available from Botswana Key Informants



■ **Table 3.10 Available health services in Botswana** *Available from Botswana Key Informants*

	Current Miners		Ex-Miners	
	Current Miners	Communities	14	7
TB			10	8
Screening	19	18	14	8
Prevention	16	8		
Treatment	19	18	6	6
MDR TB			4	6
Screening	12	10	5	8
Prevention	10	10		
Treatment	9	9	13	8
HIV			11	6
Screening	17	18	0	0
MMC	12	12	6	3
Prevention	4	2		
Treatment	16	16	2	4
Silicosis			1	3
Screening	6	1	1	4
Prevention	3	1		
Treatment	7	1	17	
			11	
Public Health	14	7	1	
NGO	5	5		
Mine Occupational Health Services	10	2		

TB and MDR-TB prevalence

TB prevalence is perceived to be high among miners, ex-miners and their communities. Miners are assumed to be at higher risk due to harsh working conditions. TB is also perceived to be high due to the high HIV infections among miners. One of the informants stated that TB is high in Selebi Phikwe and Jwaneng where most mines are situated. A third of the informants said that most cases of TB are found among miners and ex-miners who were previously employed in South African mines.

"We have cases of TB of ex-miners but mostly from South African [mines] not from Botswana [mines]"

(KI028, Mine Health)

Six out of 10 informants noted that adherence to TB treatment is good. However, four reported that adherence to TB treatment amongst miners is bad compared to the general population, *"It's okay because when the treatment is there, they take it. But the problem start when they leave the mine job"* (KI027, Department of Health). Two out of 11 informants stated that MDR-TB is high in Botswana. One said that MDR treatment adherence is high because MDR-TB patients are hospitalised until they complete treatment.

HIV

About 45% of informants reported HIV prevalence to be high in Botswana and one informant said that Selebi-Phikwe has the highest prevalence in the country.

Silicosis

Most informants (75%) commented that they do not know much about silicosis. One informant stated that Botswana mines do not have any silica dust and those who are diagnosed with silicosis are referred to South Africa, with their chest X-rays for further care and support.

"Not that I know of. Most miners are referred to South Africa with their x-rays"

(KI032, Department of Health)

Summary of key Findings

TB and HIV prevalence are high in Botswana

TB notification rates have reduced over the years, with a reported TB incidence of 385 per 100 000 in 2014. The TB epidemic mimics that of the HIV epidemic, increasing from 206 in the 1990s to 623 in 2002. The districts most affected by TB disease are not mining areas, though the mining areas still have a high TB incidence compared to the national average. TB Incidence in ex-miners is estimated at 132/100 000 and pneumoconiosis prevalence at 10%. HIV prevalence is the general population is 18,5%, but the mining areas (Selebi-Phikwe and Sowa) have the highest prevalence in the country.

Data Gaps and Limitations

Little information has been published or is available as grey literature on miners' health and prevalence of diseases like HIV, TB and silicosis. The TB case data reported on miners from two mining companies does not include the total population of the mine workers or people employed, making it impossible for TB incidence in miners to be estimated.

Conclusion

Botswana is a developing country, with a progressive upper-middle-income economy. Botswana was the first southern African country to implement testing and treatment for HIV. This has resulted in a decreasing TB epidemic in the country, but TB and HIV remain high among miners, prisoners and refugees. The mining areas (Selebi-Phikwe, Jwaneng and Serowa) have a high TB and HIV incidence and prevalence rates. TB services are mainly accessed through the public health sector and not mine health services. Although the risk of silicosis from diamond mining is low, miners in Botswana have little awareness of silicosis. Traditional labour-sending areas to Botswana have lower HIV prevalence rates than the mining communities. Therefore, we would recommend occupational health services to focus on the Central District in Botswana.

Recommendations

- Prioritize occupational health services in the high TB incidence areas (Central Eastern districts),
- Extend occupational health services to ex-miners,
- Increase education and awareness about mine occupational health diseases,
- Disseminate information about compensation for occupational diseases,
- Increase ART coverage to over 90% in line with the UN 90-90-90 targets,
- Empower mining companies and the private sector to provide TB treatment, and
- Improve capacity (resources) to diagnose and manage silicosis.

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During the apartheid era, thousands of workers from Lesotho were forced to find work in South Africa and many were employed in gold mines.
Mining provides an opportunity for people to improve their socio-economic status despite its associated safety and health concerns.

Chapter 4: **Lesotho**

Executive Summary

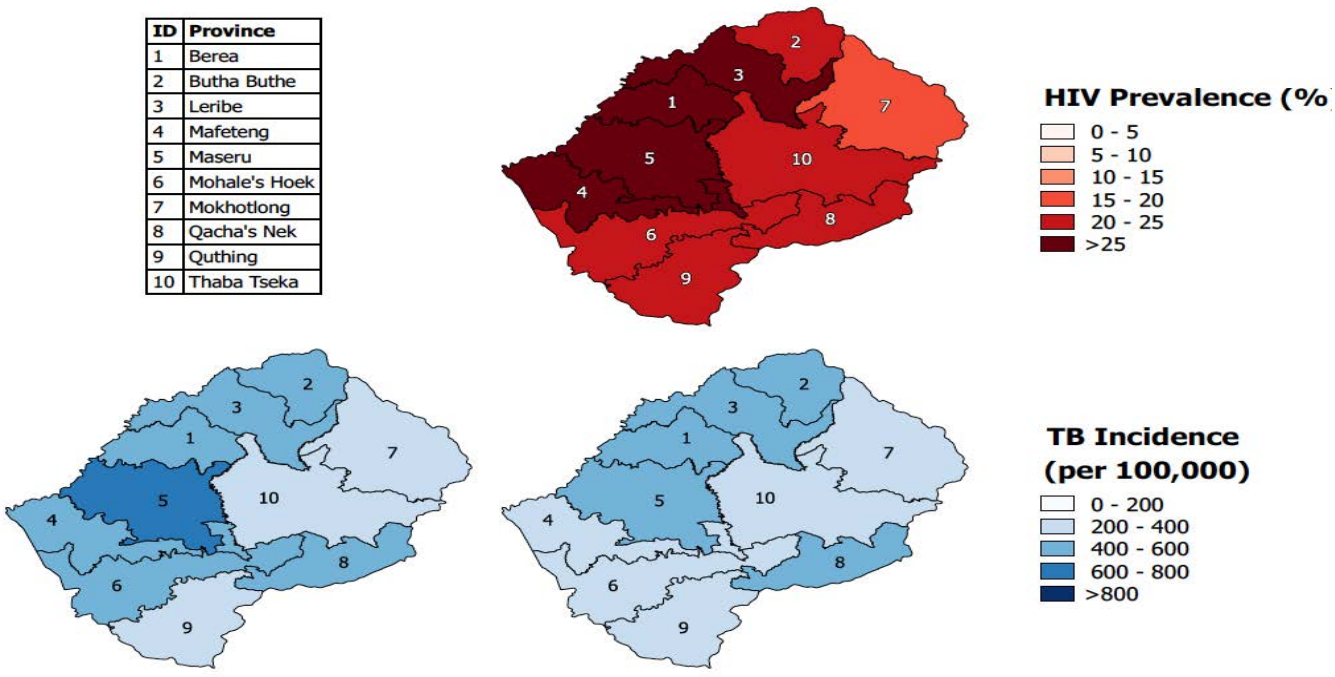
Background: Lesotho is a low-income country with a population of 2.1 million people and is economically reliant on its neighbour South Africa. Historically many Basotho men were employed in South African mines. In some districts up to 7% of the population are known to be migrant mineworkers. However, diamond mining and quarrying activities have been scaled up in Lesotho over recent years with a turnover of $300 million reported from the diamond mining sector in 2014.

Key findings: TB is a major public health problem with an estimated national incidence of 852/100 00 in 2015. The proportion of MDR TB cases amongst newly diagnosed TB patients is 3.2%. Overall HIV prevalence in Lesotho is 23%, but the prevalence varies across population groups. The districts with the highest HIV prevalence are Maseru and Berea. The provision of healthcare services in some highland areas is inadequate. Current and former miners are a high risk group for TB and MDR TB yet have less access to TB services mainly due to migration. The districts with the highest rates of TB (Maseru, Berea) also have the highest numbers of miners residing in them. The prevalence of HIV is higher in miners than the general population, with some diamond mines reporting HIV prevalence rates of 14-18%.

Limitations: Exact numbers on current and former miners as well as migration patterns and its effects on their health are not known. Virtually no information is available on levels of silicosis in the country.

Recommendations: An increase in the number of health facilities that offer TB services across the country is essential. Expansion of focused occupational health services to target areas with high levels of migrant mineworkers.

■ Figure 4.1
HIV prevelence and TB incidence in General Population and estimated TB incidence in mine workers in Lesotho

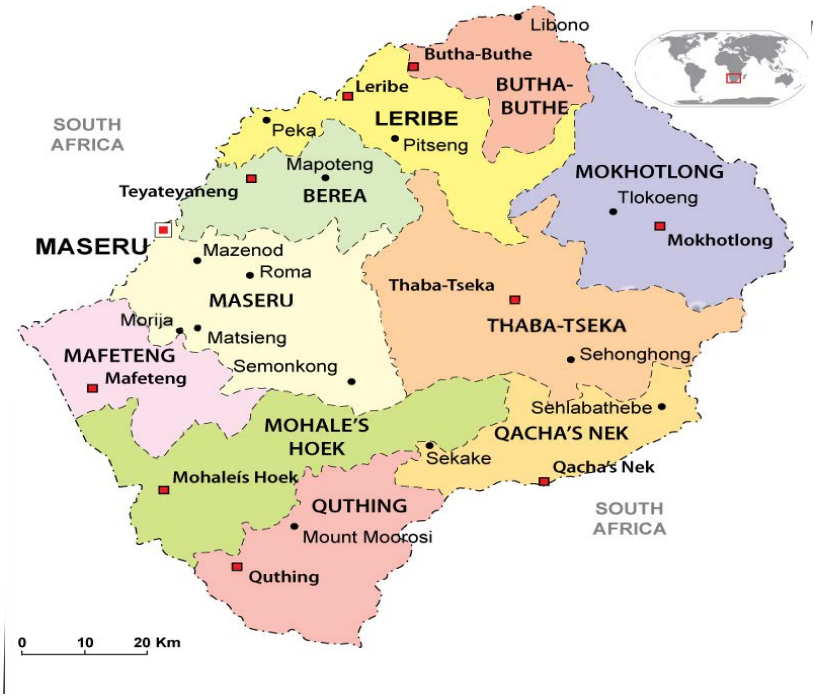


Country Profile

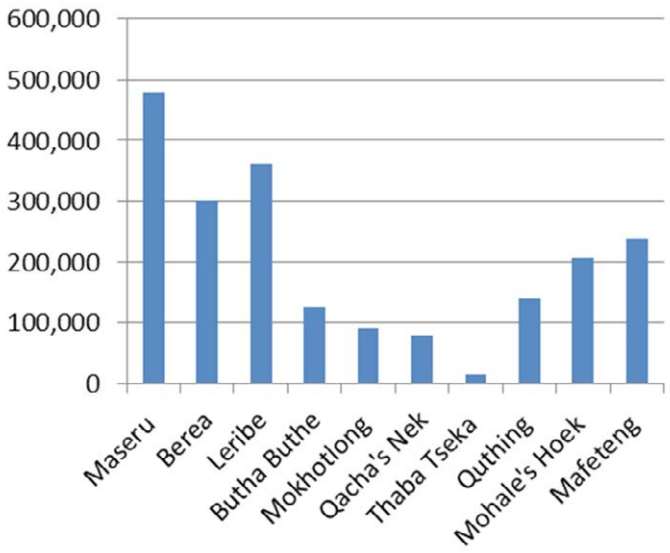
Lesotho is an enclaved, landlocked country in southern Africa, surrounded on all borders by South Africa (Figure 4.2).

It is just over 30 000 km^2 in size and has a population[1] of 2,1-million people, of whom 39% are aged 0-14 years, 56,3% are aged 15-64 years and 4,7% are aged 65 years and over[2]. Life expectancy in Lesotho is 49 years, primarily because of the high AIDS epidemic[3,4]. Lesotho has a comprehensive, co-coordinated and integrated health system based on primary health care principles[2]. Each of the country's 10 districts (Berea, Butha-Buthe, Leribe, Mafeteng, Maseru, Mohale's' Hoek, Mokhotlong, Qacha's Nek, Quthing and Thaba-Tseka) have a district health management team which supervises health and social welfare services[1]. However, in the Lesotho Highlands, people struggle through harsh weather and mountainous terrain, walking an average of four hours to access health services. Without enough staff and resources, doctors struggle to cope[5,6]. Figure 4.3 shows Lesotho population per health district. Maseru, Berea and Leribe Districts have the highest populations, while the highlands are the least populated.

■ **Figure 4.2**
Map of Lesotho
[Source: Maps of the World, http://www.mapsofworld.com/]



■ **Figure 4.3**
Lesotho Population by district
[Source: Ministry of Health www.health.gov.ls]



General Health Indicators

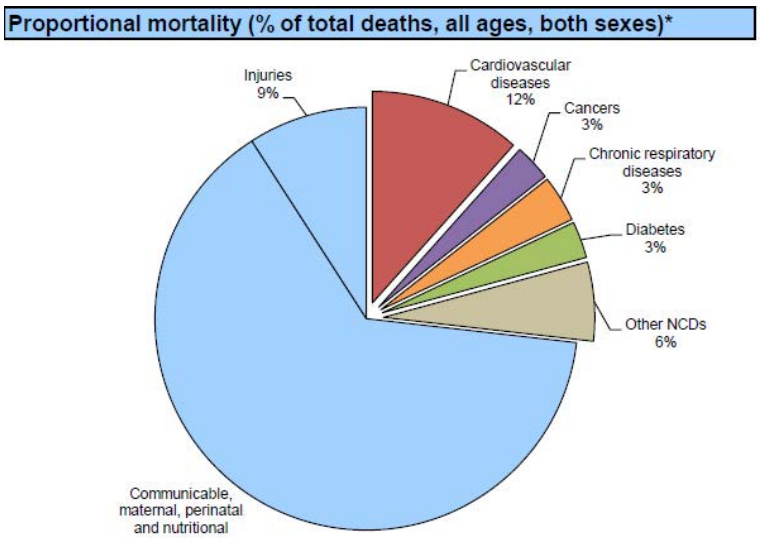
The health indicators for Lesotho have improved slightly but some formidable challenges remain.[7] The infant mortality rate has decreased from 2012 (74/1 000 to 59/1 000); under-five mortality has gone from 108 to 90,2/1 000. The maternal mortality ratio was estimated to have increased from 2005 to 2012 but has since decreased to 487/100 000 live births[8,9]. These improvements are, however, still below the Millennium Development Goals. The World Health Organization Country Strategy Cooperation for Lesotho reports causes of mortality as follows: communicable, maternal, perinatal and nutritional conditions (64%), cardiovascular diseases (12%), injuries (9%), other non-communicable diseases (6%), and cancers, chronic respiratory diseases and diabetes (3% each) (Figure 4.4)[3].

Table 4.1 shows Lesotho's health indicators according to the WHO report[9].

Overall, in Lesotho there are 20 hospitals and 186 clinics (Table 4.2), with most facilities located in the capital Maseru.

The burden of non-communicable diseases has increased, and the burden of communicable diseases is high. Surveys conducted in 2001 and 2012 show that the prevalence of hypertension was 31% and diabetes 1,3%[10]. Strokes and heart failure accounted for 6% of male and 2% of female deaths, respectively[10]. Diarrheal diseases (4%) were among the top 10 diseases seen in outpatient departments[10].

■ **Figure 4.4**
Proportional Mortality
[Source: WHO Country Strategy Cooperation http://www.who.int/countryfocus/cooperation_strategy/ccsbrief_lso_en.pdf



■ **Table 4.1** Health Indicators *[WHO,2016]*

Current Health Indicators	
Total population in thousands (2015)	2135
% Population over 15 (2015)	36,1
% Population over 60 (2015)	6,2
Life expentancy at birth	51.7 (Male), 53.7 (Both sexes), 55.4 (Female)
Neonatal mortality rate per 1000 live births (2015)	32.7 (25.2-45.5)
Under-five mortality rate per 1000 live births (2015)	90.2 (70.2- 115.0)
Maternal mortality ratio per 100 000 live births (2015)	487 (310- 871)
% DTP3 Immunization coverage among 1-year olds (2014)	96
% Births attended by skilled health workers (2014)	77,9
Infants exclusively breastfed for the first 6 months of life (%) (2009)	54
Density of physicians per 1000 population	
Density of nurses and midwives per 1000 population	
Total expenditure on health as % of GDP (2014)	10,6
General goveernment expenditure on health as % of total government expenditure (2014)	13,1
Private expenditure on health as % of total expenditure on health (2014)	23,9
Adult (15+) literacy rate total (2007-2012)	90
Population using improved drinking water sources (%) (2015)	81.8 (Total), 94.6 (Urban), 77.0 (Rural)
Population using improved sanitation facilities (%) (2015)	30.3 (Total), 27.6 (Rural), 37.3 (Urban)
Poverty headcount ratio at $1.25 a day (PPP) (% of population)	
Gender inequality index rank out of 155 countries (2014)	124
Human Development Index rank out of 158 countries (2014)	161

■ **Table 4.2** Health District Hospitals and Clinics in Lesotho *[Source: Ministry of Health www.health.gov.ls]*

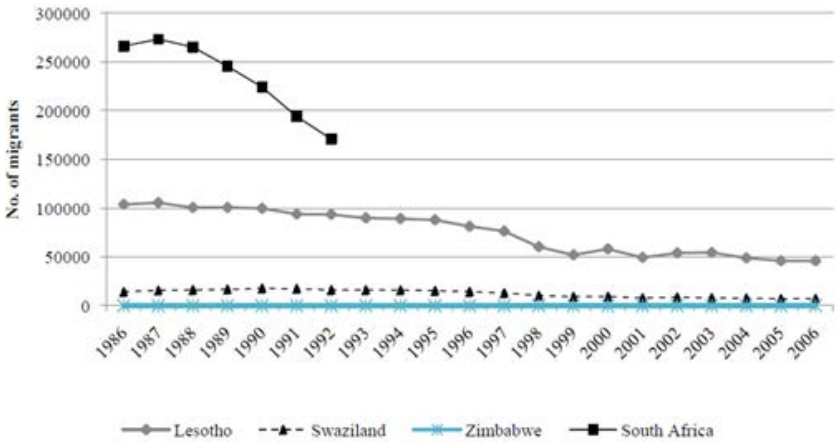
Site	Number of Hospitals	Number of Clinics
Lesotho	20	186
Maseru	6	49
Berea	2	12
Leribe	2	33
Butha Buthe	2	10
Mokhotlong	1	10
Qacha's Nek	2	12
Thaba Tseka	2	20
Quthing	1	9
Mohale's Hoek	1	12
Mafeteng	1	19

Attendance by skilled health workers during delivery has improved to 61,5%, while antenatal care coverage stands at 92,1%[7]. Child immunization coverage deteriorated in 2013, with measles coverage dropping to 59%.[7] The country's health system faces several problems that include: an acute shortage of human resources for health; an inability to absorb all funds allocated to the health sector; outdated health legislation; a weak health system; inequalities and inequities in service delivery; and a difficult terrain, as most parts of the country are hard to reach.[7]

Mining Landscape

Lesotho's economy is based on agriculture, livestock, manufacturing and mining.[11] In 2012, 57% of the population in Lesotho was living below the poverty line. Lesotho is heavily reliant on South Africa for economic survival.[12] During the apartheid era, thousands of workers from Lesotho were forced to find work in South Africa and many were employed in gold mines.[11] Mining provides an opportunity for people to improve their socio-economic status despite its associated safety and health concerns. Many Basotho miners are still employed in South Africa, but much fewer than before. (Figure 4.5).

■ **Figure 4.5**
Number of migrants in the South African gold mines, by country of origin, 1986-2006
[Source: Corno and de Walque. http://jae.oxfordjournals.org/content/21/3/465.abstract]



■ **Table 4.3 Profile of Basotho ex-miners**
Source: Clinton health. http://www.clintonhealthaccess.org/chai-annual-report-2014/]

Ex-Miner Profile	
Known population of miners who have completed service (post-service mortality not recorded)	129 355
Estimated number of living ex-miners (based on ASDR and CSDR calculations)	65 000 -75 000
Average age	59 years
% working in gold mines	86%
Average # of years since last retrenchment	17,6 years
Average # months worked in service	156 months (13 years)
Average service term (retirement year - start year)	16,7 years

Water and diamonds are Lesotho's significant natural resources.[11] In 1957, a diamond mine was established on top of the Maluti Mountains in north-eastern Lesotho, 70km from Mokhotlong at Letšeng.[13] Diamonds are mined at the Letšeng, Mothae, Liqhobong and Kao mines, which combined are estimated to have produced 240 000 carats of diamonds worth $300 million in 2014. The Letšeng mine is estimated to produce diamonds with an average value of $2 172/carat, making it the world's richest mine on an average price per-carat basis[14]. Figure 4.6 highlights the size of the diamond mining workforce in Lesotho.

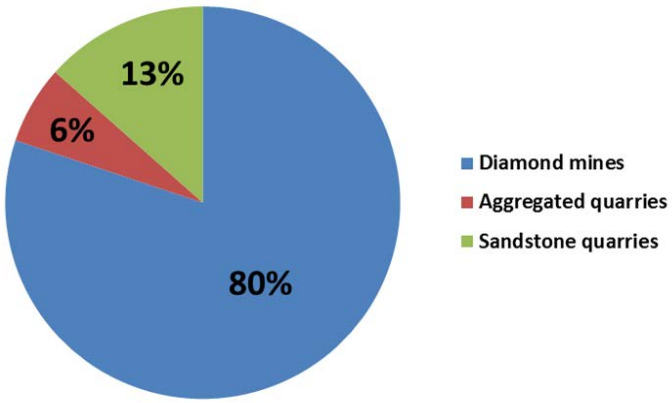
Since there are operational mines in Lesotho, labour inspection services began operations in 1986[15]. The Occupational Safety and Health (OSH) department inspects workplaces, conducts surveys, and investigates accidents, dangerous occurrences and work-related diseases, and monitors adherence to Occupational Safety and Health legislation[15]. The OSH Promotional Services Unit provides relevant training to social partners to enhance the understanding of their duties and obligations in promoting safety and health; promotes and implements the National HIV/AIDS Policy at workplaces; compiles and analyses statistics on occupational safety and health; and disseminates information on OSH.[15]

The most recent mining population in Lesotho is reported to be 15 911: this number includes only current migrant miners employed in South Africa mines, (Table 4.4).[16] Most reside in Maseru, Leribe, Mafeteng, and Mohale's Hoek. Quthing, Qacha's Nek, Thaba Tseka and Mokhotlong have the lowest population of miners.[16] However, TEBA data shows that the number of current and ex- miners in Lesotho is closer to 192 047 (2016

Table 4.4 Mining Population per Health District based on Mapping studies and TEBA data
[Source: Mapping studies and TEBA data]

Site	Mapping Studies		TEBA Data	
	Number of mining population	%	Number of mining population	%
Maseru	3 317	21%	37 396	19%
Berea	1 809	11%	20 855	11%
Leribe	3 223	20%	21 431	11%
Butha Buthe	1 088	7%	13 456	7%
Mokhotlong	346	2%	8 321	4%
Qacha's Nek	417	3%	8 656	5%
Thaba Tseka	358	2%	5 125	3%
Quthing	819	5%	14611	8%
Mohale's Hoek	1 782	11%	3 3070	17%
Mafeteng	2 752	17%	2 9126	15%
Totals	1 5911	100%	1 92047	100%

Figure 4.6
Mine and quarry workers by commodity in Lesotho
[Source: Clinton health. http://www.clintonhealthaccess.org/chai-annual-report-2014/]



TomTom estimates). The profile of Basotho ex-miners is summarised in Table 4.3. In some districts, as high a figure as 7% (Mafeteng) of the population are migrant miners.[17]

Based on the TEBA data, the highest number of miners are in Maseru, Mohale's Hoek, Mafeteng, Leribe and Berea (Figure 4.7).

All four of the districts with the high number of miners border the Free State Province in South Africa, where historically much gold mining took place and which offered easy employment opportunities (Figure 4.8). The South African mining industry has a huge impact on migrant miners from Lesotho working in South Africa. The industry says is committed to the principle of zero harm, with the goal that every mineworker should return home unharmed.

The districts with the highest number of in country-mining activity are Maseru, Berea, Butha-Buthe and Mokhotlong (Figure 4.9).

The primary health challenges for miners vary from sector to sector, with little available data on artisanal and small-scale mining in Lesotho (sandstone quarries). Occupational lung disease, particularly silicosis, is a major issue in the gold and coal sectors. Basotho miners working in South African gold and coal mines risk developing silicosis. Silicosis is classified as a compensable occupational health illness in South Africa,[18] and Basotho

Figure 4.7
Miner population by district, 2012
Source: Clinton Health Access Initiative. Health Findings and Recommendations: RSA Migrant Miners in Lesotho

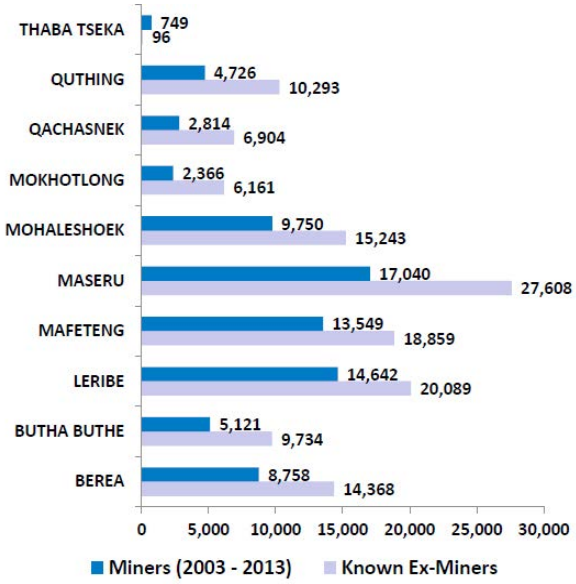


Figure 4.8
Health District with highest number of miners

miners previously employed in South African mines should be able to claim compensation.

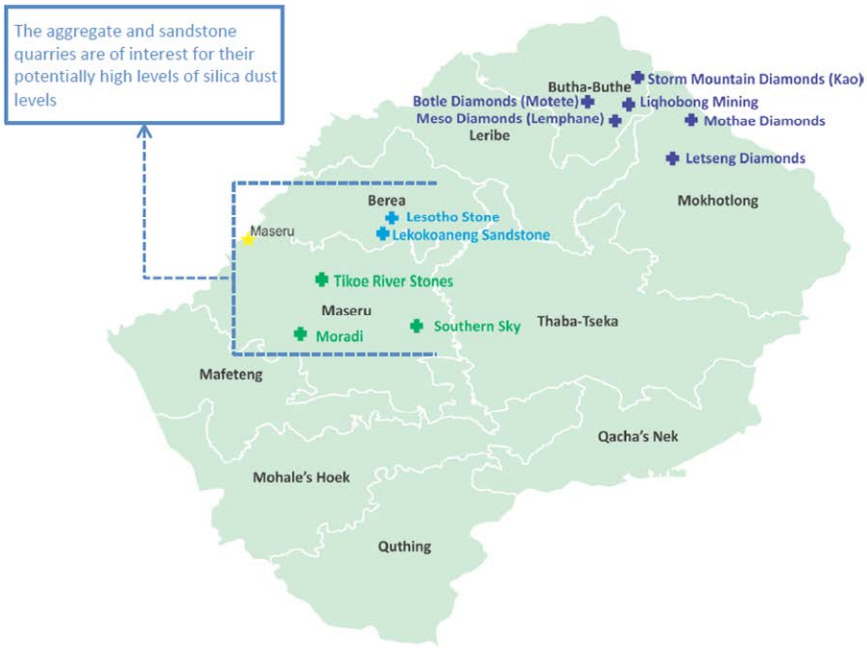
Both pulmonary TB and HIV are significant public health threats in Southern Africa, with often debilitating and potentially life-threatening consequences for mine workers and their communities. Where TB develops in the presence of silica dust exposure, this becomes an occupational illness[18]. The risk of TB remains high among former miners. The estimated TB incidence rate reported in a study of in-service miners was over 3 000 per 100 000 per year.

Results

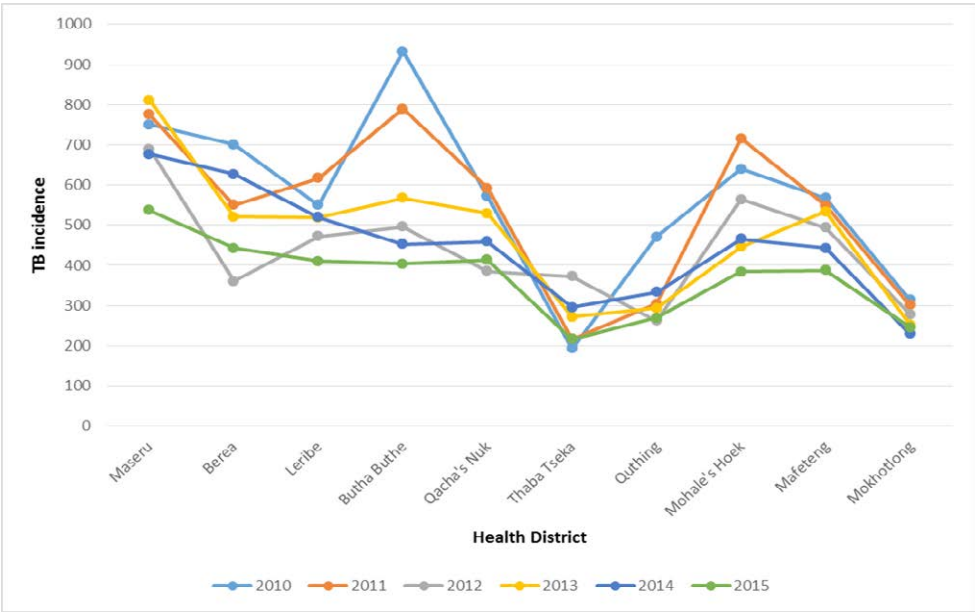
General Population TB and HIV Epidemiological Data

TB is a major public health problem in Lesotho, with an estimated incidence in 2006 of 696/100 000[1] increasing to 852/100 00 in 2015, of which 3,2% was estimated to be drug resistant,[19] making it the third highest per capita TB burden country in the world. In 2015, Lesotho reported 8 840 (new and re-lapse) cases of all forms of TB[19]. Across the population in Lesotho, TB is more prevalent in men, with the highest number of cases (1 770) reported among 45-54-year-olds.

■ **Figure 4.9**
Mines and quarries in Lesotho
[Source: Clinton health. http://www.clintonhealthaccess.org/chai-annual-report-2014/]



■ **Figure 4.10**
TB Incidence by Health District in Lesotho (2010-2015)*
[Source: Department of Health Data]
**excluding private facilities*

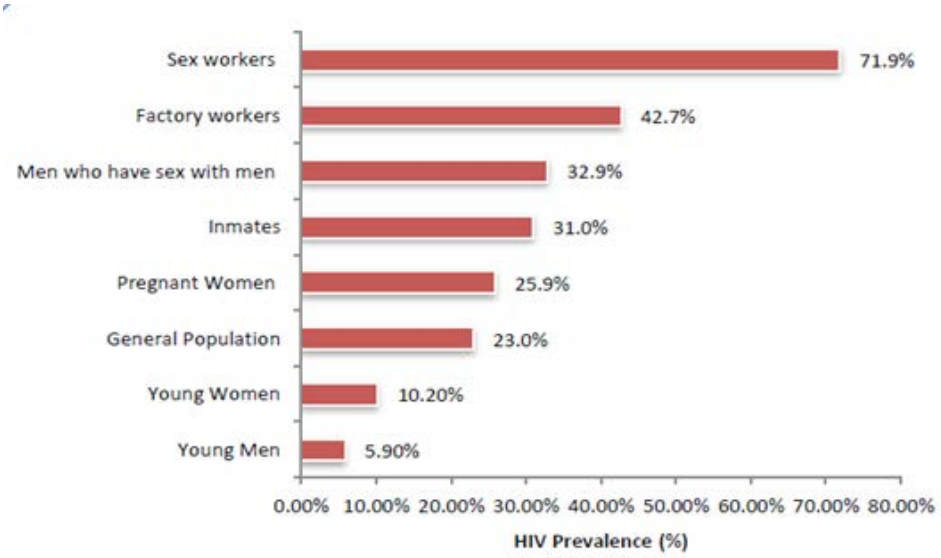


TB incidence in Lesotho by district is summarised in Figure 4.10, below. Butha Buthe district had the highest TB incidence in 2010 however, this has significantly dropped by half in 2015. The incidence of TB remained above 400 per 100 000 in Maseru, Berea, Leribe, Butha Buthe and Qacha's Neck.

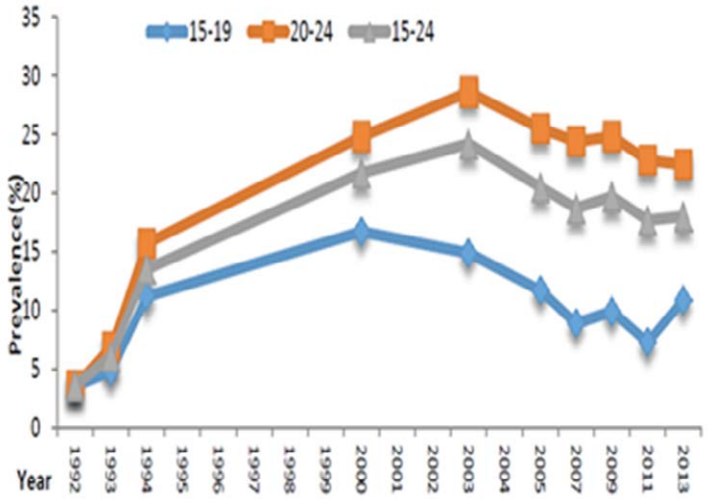
HIV and TB co-infection is high: 93% of patients with TB had a known HIV status, of which 72% were HIV and TB co-infected. Also, 74% of HIV-infected patients were also on ART during the period they were treated for TB. Three quarters (75,3%) of the patients were treated successfully for TB, while 5,7% were lost to follow-up, 10,1% died, 1,4% had treatment failure and 7,4% were not evaluated. The rate of HIV infection among adults in Lesotho is one of the highest in the world[20]. There are 310 000 people living with HIV, resulting in an overall general population prevalence of 15%[21]. However, HIV prevalence is highest (23%) among 15-49[21] year olds and varies among different subgroups (Figure 4.11).

HIV prevalence among sex workers is estimated to be 3 times higher than the general population (72% compared to 23%), largely because of: widespread violence; criminalization; stigma and discrimination; lack of funding for treatment; and targeted treatment programmes. HIV prevalence among men who have sex with men is estimated to be 1,4 times higher than the general population (33% compared to 23%); and prevalence of HIV in prison populations is estimated to be 1,3 times higher than the general population (31% compared to 23%). Nearly one-in-three (31%) of the estimated 2 500 inmates are living with HIV[11].

■ Figure 4.11
HIV prevalence among different subgroups
[Source: Global AIDS Response Progress Report. http://www.unaids.org/sites/default/files/country/documents/LSO_narrative_report_2015.pdf]



■ Figure 4.12
HIV Prevalence Trend among ANC Young Women between 1991 to 2013
[Source: Global AIDS Response Progress Report. http://www.unaids.org/sites/default/files/country/documents/LSO_narrative_report_2015.pdf]



The disproportionate burden of HIV for Basotho women reflects a persistent trend in sub-Saharan Africa, where 58% of people living with HIV/AIDS are women[20]. Figure 4.12 shows the HIV prevalence trend among Basotho ante-natal-care young women between 1991 and 2013[21]. Although HIV prevalence has decreased since 2003 across all age categories, in 2011 HIV increased in ante-natal-care young women aged 15-19 years.

Key factors associated with reducing new HIV infections include: declining multiple sexual partners, increased knowledge about HIV, increasing condom use during last sexual intercourse with persons having multiple partners and declining proportion having sex before age 15[21].

By end of 2006, a reported 1 436 children (less than 15 years of age) were receiving antiretroviral therapy (ART) at hospitals, health centres and private practitioners' clinics across the country[1].

According to the 90-90-90 strategy, 90% of all people diagnosed with HIV will receive sustained antiretroviral therapy[22]. Figure 4.13 shows National ART Cohort Outcomes 2008-2012[21]. The trends in the proportion of people alive and on ART ranged between 70% and 80% between 2008 and 2012. Loss to follow-up was about 20%, with the lowest figure (10%) reported in 2012 while percentage of those who died is below 10%[21]. These denote high losses of people on treatment[21].

Figure 4.13 shows an estimated ART coverage by district in 2014 among adults, children, and pregnant mothers. Adult and child coverage is lower than half in all districts except Butha-Buthe, while coverage among pregnant mothers is higher in the districts of Butha-Buthe, Maseru, Berea and Leribe[21].

Figure 4.13
National ART Cohort Outcomes 2008-2012
[Source: Global AIDS Response Progress Report. http://www.unaids.org/sites/default/files/country/documents/LSO_narrative_report_2015.pdf]

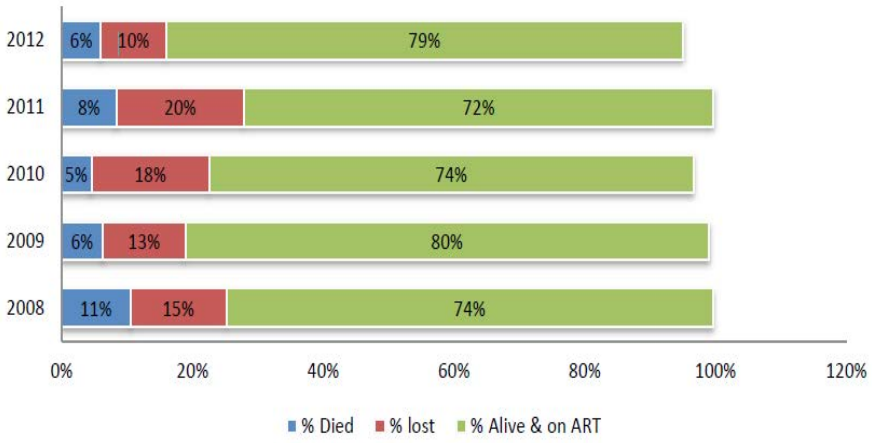
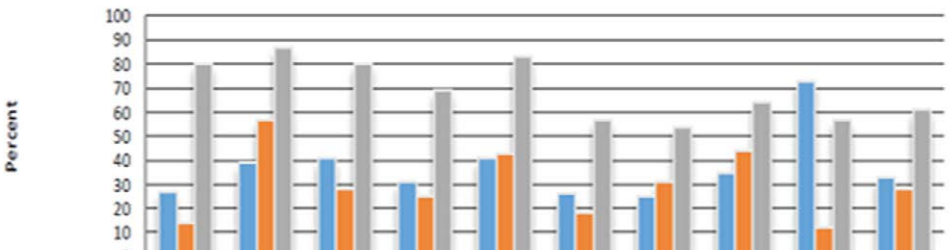


Figure 4.14
Estimated ART coverage among adults, children and pregnant mothers in 2014
[Source: Global AIDS Response Progress Report. http://www.unaids.org/sites/default/files/country/documents/LSO_narrative_report_2015.pdf]



	Berea	Butha-Buthe	Leribe	Mafeteng	Maseru	Mohale's Hoek	Mokhotlong	Qacha'sNek	Quthing	Thab-Tseka
Adults on ART	27	39	41	31	41	26	25	35	73	33
Children on ART	14	57	28	25	43	18	31	44	12	28
PMTCT	80	87	80	69	83	57	54	64	57	61

Miners TB, HIV and Silicosis Data

Miners and ex-miners constitute a large proportion of adult male TB and MDR-TB cases in Lesotho[23]. In general, miners are considered to be a high risk group for TB, with 771 new cases of TB reported in 2015 of which 154 were in Maseru and 136 in Mafeteng (Table 4.5 and Figure 4.15). In general, the number of new TB cases corresponds to the size of the mining population in those districts. In 2011 around 384 Basotho miners and ex-miners were receiving TB treatment. This number is, however, low compared to the number of new cases reported.

Miners have a higher HIV prevalence compared to the general population. In a diamond mine in Butha Buthe, the employee HIV prevalence was 14% compared to the district prevalence of 10,6%[17]. Similarly, a mine in Mokhotlong reported an employee prevalence of 18% compared to the district prevalence of 15,9%[17]. HIV testing, diagnosis and treatment services are offered to miners across some domestic mines in Lesotho (Figure 4.16)

Published Literature

As part of the secondary data review, existing research publications and reports for Lesotho have been summarised. In total, we have reviewed four research publications that covered the periods 2002, 2008, 2009 and 2012. Gold was the primary investigated commodity. The target populations for the studies were miners and ex-miners.

1. *Corno and de Walque (2012)*, examined whether participation in mining in a bordering country affected the HIV infection rate in Zimbabwe, Swaziland and Lesotho[24]. Using the Lesotho country specific Standard Demographic and Health Surveys (DHS) conducted in 2006-2007 and looking at miners and their partners, the overall findings were that migrant miners (40%) and their partners (36%) are more likely to be HIV infected[18]. Wives and partners of men working in the mining sector would benefit from being the focus of HIV prevention interventions.
2. *Park et al. (2009)* published results of a cohort study in which 776 ex-miners were followed-up after the mine closed. The study outcomes revealed silicosis worsened between the two visits, one year apart[25].

Table 4.5 Number of new cases of TB among high risk groups in Lesotho by district in 2015
[Source: Department of Health Data]

District	Miners/Ex Miners Cases	Health Workers	Factory Workers	Prison In mates
Berea	76	5	81	0
Butha Buthe	74	3	64	0
Leribe	114	2	42	1
Mafeteng	136	0	22	1
Maseru	154	8	264	11
Mohale's Hoek	62	1	9	6
Mokhotlong	33	3	12	0
Qacha's Nek	38	2	12	3
Quthing	30	2	0	2
Thaba Tseka	54	2	12	1
Total	**771**	**28**	**518**	**25**

■ **Table 4.6 Summary of Lesotho Research Publications**

Reference	Population	Commodities (List)	Method)	Prevalence and Incidence	Comments
Park HH, Girdler-Brown BV, et al. Incidence of ...Tuberculosis and HIV and Progression to Silicosis…., 2009, AJ of Industrial Medicine	Ex-Miners	Gold	A cohort of 776 miners were followed-up after mine closed, 18 months baseline, 1 year after baseline	**PREVALENCE** **HIV:**19,5% (93/478) **TB:**7,2%(37/513) **Silicosis:** 26.4%(134/508) **INCIDENCE HIV:** 5,4 cases per 100 person-years **TB:**3085 per 100000 per year	Silicosis worsened between the two visits 1 year apart
Girdler-Brown BV, White NW, et al. The burden of silicosis, Pulmonary Tuberculosis and COPD among former Basotho Goldminers. 2008, AJ Industrial Medicine	Ex Miners	Gold	Cross Sectional Study of Ex-miners 18 months after cessation of employment	**PREVALENCE** **HIV:** 22.3% **TB:**1.3% (8/624) **Silicosis:** 24.6%	Participants had a medium or high dust exposure. Prevalence of past TB was 26%. Current smoking was 35%, ever smoked 61%, COPD 13,4%.
Corno L and de Walque D. Mines, migration and HIV/AIDS in southern Africa. By the World Bank Development Research Group. Human Development and Public Services Team. February 2012	Miners aged 30-44 years and their partners	Not-specified	Standard Demographic and Health Surveys (DHS) in the 3 countries	**PREVALENCE** **HIV:** Men - 40% and Women partners - 36%	The likelihood of HIV infection increases for individuals employed in the mines in the age range between 30-44 years old. The paper also shows a previously unexplored finding: women who have a husband or a cohabiting partner employed in the mining sector are also more likely to be tested HIV positive. Furthermore, miners and their wives are less likely to adopt safer sexual behaviors. Wives and partners of men working in the mining sector would also benefit from being the focus of HIV prevention interventions.
Brummer D. Labour Migration and HIV/AIDS in southern Africa. By IOM. April-Sep 2002	Basotho miners	Not-specified	40 Semi-structured in-depth interviews		Factors that contribute to HIV/AIDS vulnerability in mine workers, and their communities are diverse, complex and not fully understood. Interventions must take into consideration their unique pressures, constraints and living environments in order to address their vulnerability effectively.

3. *Girdler-Brown et al. (2008)* published a cross-sectional study of ex-miners 18 months after termination of employment. The study results showed that participants had a medium or high dust exposure. Prevalence of past TB was 26%, current smoking was 35%, ever smoked 61% and Chronic Obstructive Pulmonary Disease (COPD) was 13,4%[26].
4. *The International Organization for Migration (2002)* conducted a qualitative study of Basotho mineworkers at field offices of The Employment Bureau of Africa (TEBA) across two districts in Lesotho. Most respondents were employed during the time of the interview, while eight were recently retrenched. The aim of the paper was to investigate the interrelatedness of labour migration and the HIV epidemic from the point of view of the miner[27].

Perceptions of Key Informants

Population Description

A total number of 14 participants of median age 38 (IQR: 32-55) years were interviewed in Lesotho. Most were from the Department of Health (4) and International Health Organisations (4) (Figure 4.17A).

The informants had varied educational backgrounds with most trained in the healthcare profession (Figure 4.17B).

Occupation of the informants ranged from health professionals (medical doctors, nurses, and medical laboratory scientists), to engineers, economists and sociologists, with the median years in current role six (IQR: 3-8) years.

Figure 4.15
TB cases among Miners and Ex Miners by Health District in Lesotho (2015)
[Source: Department of Health Data]

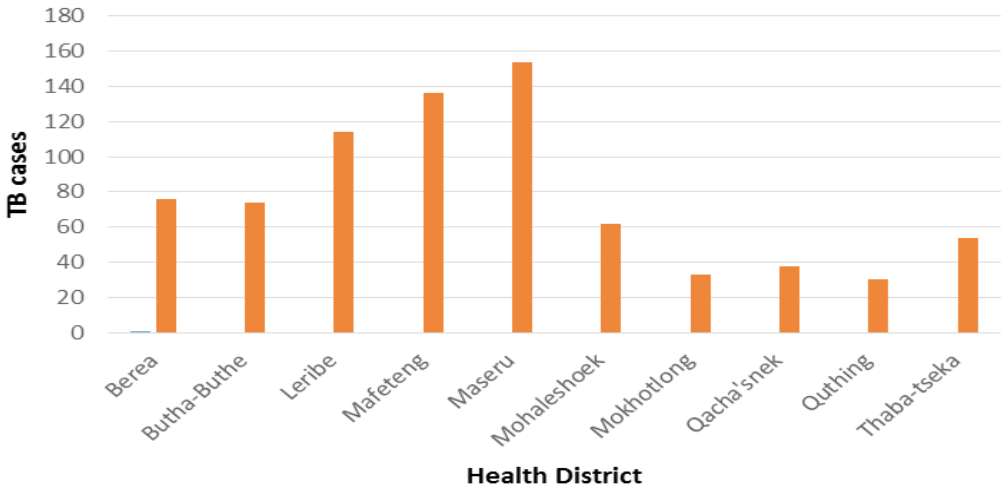
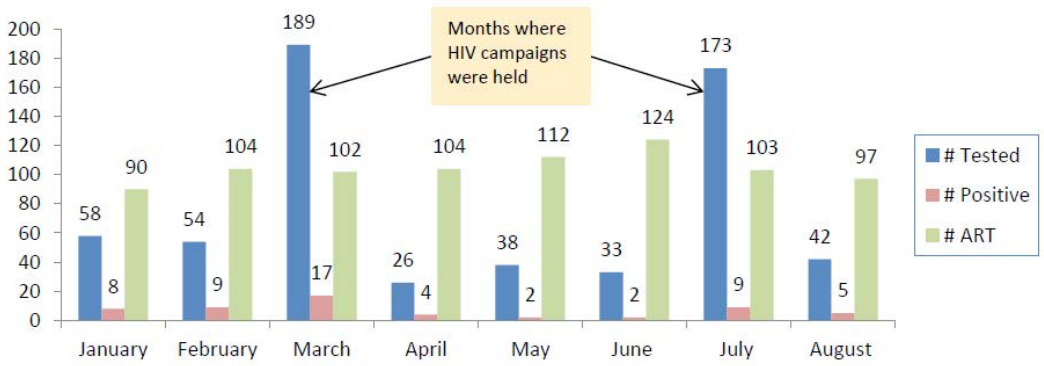


Figure 4.16
HIV testing, diagnosis and treatment across diamond mines in Lesotho, 2014
[Source: Clinton health. http://www.clintonhealthaccess.org/chai-annual-report-2014/]



Mining

Lesotho has few established and regulated mines: most Basotho men are employed at South African mines. The most common types of mining activities are surface mining and quarrying. The main mining companies are: Letšeng, Liqhobong, and Lekokoaneng Sandstone, Lemphane and Moradi Crushers (Table 4.9). Although Letšeng diamond mine was temporarily closed, it is reported to be performing better.

The informants interviewed considered the Lesotho health services inadequate, especially in the highlands, where access is a challenge. Informants spoke about clinics that are not within reach of community members. Miners, ex-miners and their families are forced to walk long distances to the nearest clinic or hospital. At times, harsh weather (snow, heavy rain and storms) make it difficult for people to access health services, resulting in poor adherence to treatment. In general, health facilities suffer from a shortage of doctors and nurses and malfunctioning equipment. Some informants mentioned that only one occupational health facility in Maseru is functional and is staffed by one occupational health doctor.

Letšeng mine offers general health screening to employees at the start of employment. Additionally, informants reported, that it is the only mine in the country that offers health care facilities to current miners and their families. The Letšeng mine primary healthcare centre works with state health facilities. If patients have a severe illness, the mine healthcare centre refers them to the state hospital for further treatment. Unlike Letšeng, most of the small-scale mines do not have clinics at their premises, so their employees use the nearest state clinics or hospitals. Even though private healthcare is subsidised by the government, patients still must pay more than at state facilities. Ex-miners and their communities can use state healthcare facilities at nominal cost. However, most current miners diagnosed with TB and/or HIV can access health services at the mine health facilities, public health facilities, TEBA clinics or the Christian Health Association of Lesotho (CHAL) health facilities.

Figure 4.17
Sectors represented by key informants

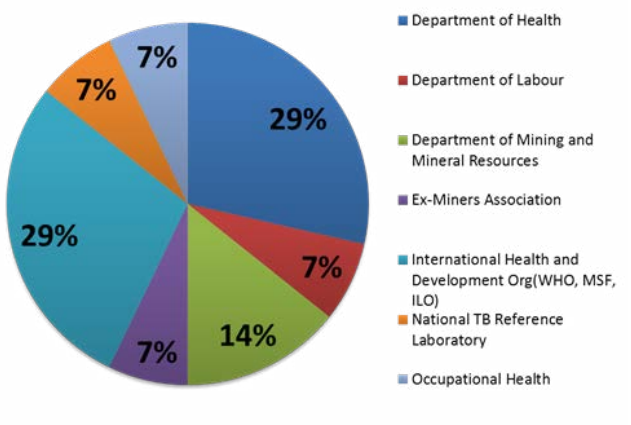
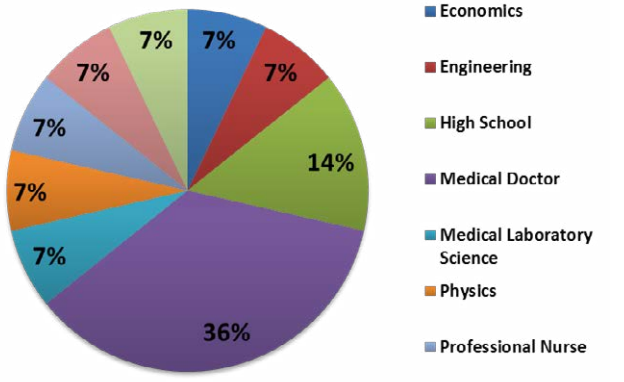


Figure 4.18
Training of Key Informants (% rounded)



Health and legislation system

According to some informants, Lesotho does not have specific labour legislation pertaining to the mining industry. Labour legislation and compensation guidelines are for the general working population and only cover work-related injuries, not diseases.

"...ad hoc-basis compensation is only required for related injuries in Lesotho. There is no legislation compensation for work-related disease or health conditions. This is in contrast to legislation in South Africa [where] The Occupational Disease in Mines and Work Act which provide compensation for health conditions such as silicosis, occupational TB and hearing loss"

(KI026, International Health and Development Organisation)

TB and MDR-TB Prevalence

Based on the interviews, 64% of the informants indicated that current miners have access to TB screening and treatment in the country from mine, NGO and state health facilities. However, only 42% of the informants reported that current miners have access to TB prevention in Lesotho. TB treatment is offered for free at state health facilities in Lesotho, but despite this, some miners choose to return to work before completing their six-month TB treatment. Many of those recorded miners are assumed to be cross-border migrants who were employed in South African mines, thus making contact tracing difficult.

"According to the data from 2012, 40 percent of all adult male TB cases in the country (Lesotho) were either current miners or ex-miners..."

(KI026, Non-Government Organisation)

Most informants reported knowing about MDR-TB in the country, with 28% indicating that current miners have access to MDR-TB screening services; 21% of informants reported knowing about MDR-TB prevention and treatment services offered for current miners. According to the interviewed informants, MDR-TB treatment is offered for free to ex-miners.

"There is high rate of MDR-TB among miners compared to the general population".

(KI015, Department of Health)

Informants perceived MDR-TB to be high among current miners, ex-miners and their communities. The proportion of MDR-TB among ex-miners was reported to be twice that of the general population, with a rate of 7%. Some of the informants (38%) mentioned that adherence to MDR-TB treatment is high as most patients are hospitalised and followed up by a dedicated healthcare team. Few cases of MDR-TB treatment defaulters are reported. Some of the perceived reasons for defaulting are migration, limited knowledge of MDR-TB, fear of job loss and reduced income while in care.

"Miners refuse MDR RX, it means salary loss for 18 months"

(KI018, International Health)

HIV Prevalence

Key informants (35%) indicated that HIV screening services are offered to current miners. None of the informants reported any specific prevention and treatment services offered at the mines for employees. Medical Male Circumcision (MMC) services are available to current miners and their communities. Additionally, 43% of the informants indicated that communities of current miners have access to HIV screening at health services. Some informants noted that not many studies have been done on HIV among miners, and many perceived HIV to be high among miners compared to the general population.

"The prevalence is very high, miners stay without their families and end up having multiple partners."

(KI025, International Health and Development Organisation)

Twenty nine percent of informants stated that ex-miners have access to HIV screening and treatment. Only 21% informants stated that ex-miners have access to HIV prevention services. According to 40% of the informants, HIV prevalence is high among ex-miners and their communities. One of the reasons given is risky sexual behaviour and migration.

Only a few informants reported on HIV treatment defaulters. Poor adherence to HIV treatment is perceived to be due to migration, stigma, non-disclosure to spouses, side effects, feeling better on treatment, and inadequate ARV programmes at work places.

"Adherence to HIV medication in mining communities that have strong HIV programmes within their mining clinics is high but is expected to be lower in mining communities that don't have strong programmes as well as among migrant cross-country miners."

(KI026, International Health and Development Organisation)

Some informants perceived HIV treatment adherence to be good, especially in the well-established mines (like Letšeng) that offer health services to their employees. Usually, mine nurses do follow-ups on patients and others make use of mobile-service reminders to encourage miners to take their medication. Miners on HIV treatment usually continue to work when they are declared medically fit.

Silicosis Prevalence

Only a few informants commented on silicosis. Most informants perceived silicosis to be high among ex-miners who have worked in South African mines, especially gold mines. Informants indicated that there is only one referral state hospital in Maseru that has the capacity to offer screening, diagnosis and supportive treatment to silicosis patients. In contrast, one informant mentioned that silicosis services are offered at private clinics and hospitals. Apart from the state hospital, miners can be screened and diagnosed through the TEBA programme or mine pre-employment medicals.

"Letšeng the largest diamond mine in the country, actively screens for silicosis in its pre-employment medical and does not hire who are diagnosed with silicosis."

(KI026, Non-Government Organisation)

Summary of Key Findings

- Lesotho is a high TB and HIV burden country.
- A large number of Basotho men have previously been and still are employed in South Africa's mining industry (there is high migration).
- Districts with current mining activities do not necessarily house ex-miners.
- Current in-country mining districts are: Maseru, Berea, Butha-Buthe and Mokhotlong
- Districts with a high number of miners are: Maseru, Mohale's Hoek, Mafeteng, Leribe and Berea
- TB and HIV prevalence in the general population is highest in the districts of Maseru and Berea.
- TB prevalence among miners is also highest in Maseru and Berea.
- The most common forms of mining in Lesotho are surface and quarrying with the main commodities mined being diamond and sandstone.
- Large mines provide health services but small-scale miners, ex-miners and peri-mining communities rely on the state healthcare system.
- No specific labour legislation exists for the mining industry.
- State healthcare facilities have limited capacity for screening, diagnosis and supportive treatment of silicosis.

Table 4.7 Mining companies and minerals in Lesotho *Source: Based on the key participant interviews*

Mine Company	Area	Minerals
Letšeng Mine	Mokhotlong	Diamonds
Namkwa's Kao Mine	Butha-Buthe	Diamonds
Lemphane	Mokhotlong	Diamonds
Liqhobong	Mokhotlong	Diamonds
Lesotho Sandstone	Berea	Sandstone
Lekokoaneng Sandtone	Berea	Sanstone
Moradi Crushers	Maseru	Crushed stone

Data Gaps and Limitations

- Information on HIV prevalence among the broader mining community (ex-miners, current miners and their families) is limited to non-existent. This information is necessary to understand the full extent of the burden of disease.
- The exact number of miners and ex-miners in Lesotho who have TB and are currently on TB treatment, those that have died, and those that are lost to follow-up is unknown.
- There is a limitation in understanding how migration patterns compromise continuity of care and the communities that current and ex-miners originate from
- Little is reported on silicosis in Lesotho because of the perception that there is no silica dust in diamond mines. As a result there is a lack of capacity for silicosis diagnosis in Lesotho.

Conclusion

Lesotho is a landlocked country within South Africa. The country's terrain is divided into highlands and lowlands and most people live in the lowlands where most health services are situated. Lesotho's primary natural resources include diamonds and water. However, the economy is heavily reliant on South Africa, with many Lesotho nationals living and working in South Africa. Most of the migrant miners from Lesotho are from Maseru, Leribe and Mafeteng. TB incidence and prevalence is the third highest in the world. HIV prevalence is also regarded as one of the highest in the world, and women are disproportionately affected. In particular, many TB cases have been reported in miners (similar to factory workers) but much higher than other high risk groups (healthcare workers and prisoners). HIV prevalence in mine workers was estimated to be 14%-18% which is similar to HIV estimates in the general population. Health services for current miners are predominantly provided by larger mine companies. Small-scale mine employees, ex-miners and peri-mining communities rely mainly on the state healthcare system. Miners are at high risk of poor adherence to TB and HIV treatment mainly due to cross-border and internal migration.

Recommendations

- Occupational health services should be focused in the following districts: Maseru, Leribe and Mafeteng, to target current and ex-miners employed in South African mines.
- Mokhotlong, Butha Buthe and Berea to target current miners working in Lesotho.
- Increase facilities that screen, diagnose and offer supportive treatment for silicosis and MDR-TB.
- Increase linkages and referrals to healthcare services for cross-border migrant workers who are sick.
- Enhance HIV and TB prevention and treatment adherence strategies within peri-mining communities.
- Provide information sessions on TB and silicosis to all miners in a format that is understandable.
- Make miners aware of the compensation services offered and the procedures to follow in claiming compensation.

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Malawi's small mining industry contributes about 2,3% to the country's GDP; however, government has planned large countrywide geological surveys to increase knowledge of available minerals to grow mining's contribution to GDP to 20% by 2023, as the country moves away from an agro-based economy.

Chapter 4: **Malawi**

Executive Summary

Background: Malawi is a South East African country with a population of 17 million people mainly residing in rural areas. The mainstay of the economy is agriculture, with mining activities contributing only 2,3% of the total GDP. Historically, Malawian men were employed in South African mines but this has reduced significantly in recent years.

Key Findings: TB prevalence is lower than in most other Southern African countries, with an estimated prevalence of 334 per 100 000 in 2014. The proportion of TB patients with MDR-TB is low at 0.42%. HIV prevalence rates have been declining in the country with a reported prevalence of 9.1% amongst those aged of 15-49 years. Curent data does not show mineworkers to be at increased risk of HIV and TB. There is no data available on silicosis levels in the country.

Limitations: Very little data is available on current or former mineworkers.

Recommendations: Initiation of research studies and surveillance systems to quantify the number of current and ex miners in order to better understand the health needs of this population group.

Figure 5.1
Map of Malawi
[Source: USAID]

Country Profile

Malawi is a small, high-density population (17 million), landlocked country in South East Africa, sharing borders with Mozambique, Zambia and Tanzania (Figure 5.1)[1]. It is a low-income country and agriculture is the mainstay economic activity, with 80% of the people living in the rural areas[2]. The major challenges in the country are human development, and it is ranked 170 out 186 countries on the human development index[2]. Despite the country's significant progress in achieving some of the millennium development goals, infant mortality is still high[2]. Total expenditure on health is 8,4% of GDP, which is 18,5% of total government expenditure[2]. The government is developing a new funding strategy for health to improve the total amount allocated to health expenditure and move closer to universal coverage[2].

The country is divided into three regions (NorthSouth and central) and 28 health districts[3]. The private sector plays a big role, providing 40% of all health care services in Malawi, and 47% of all private healthcare facilities are in the rural areas where most people live[3]. Figure 5.2 shows the distribution of the various healthcare facilities in rural, peri-urban and urban areas, with urban areas having mostly pharmacies and other facilities (such as laboratories)[3]. The highest number of private facilities per 10 000 people are in Likoma (1,92), Blantyre (1,51) and Lilongwe (0,8) districts; and the lowest are Chiradzulu (0,17), Phalombe (0,16) and Ntchisis (0,1) districts[3]. The mining districts in Malawi are mostly in the northern region, in Chitipa, Karonga and Rumphi[4]9

Figure 5.2
Distribution of Private Health Facilities in Malawi
[Source: USAID, 2013]

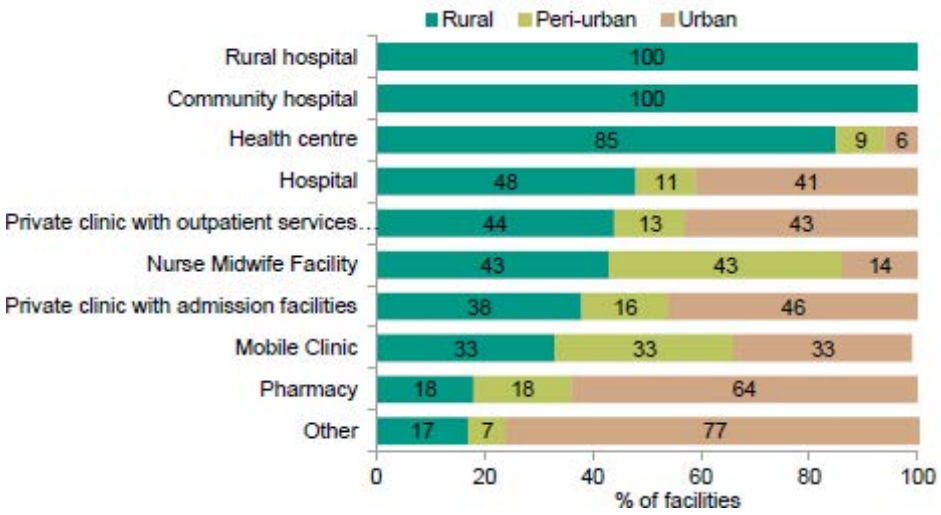


Table 5.1 Summary of Malawi Statistics *Source: World Health Organization*

Population Estimate	17 Million
Proportion Rural	80%
Average household size	4.6
Proportion under 15 years	45,44
Proportion over 60 years	4.92%
Life Expectancy at Birth	59 years
Neonatal mortality rate	24 per 1000 live births
Density of Nurses and midwives	0,283 per 1000 population
Density of Doctors	0,019 per 1000 population
Total Expenditure on health	8,4% of GDP
Population below poverty line	52,4%

General Health Indicators

The Malawi population is young, with 45,4% below the age of 15 years (Table 5.1), and only 5% above 60 years of age[5]. Life expectancy at birth for both males and females is 59 years[5]. Both child and adult mortality rates are high in Malawi due to high prevalence of communicable diseases, such as tropical diseases (schistosomiasis, trachoma and leprosy) as well as tuberculosis, HIV, and malaria, plus an increasing burden of non-communicable diseases[5]. In adults aged 25-64 years, 33% have hypertension and 5,6% are diabetic. The maternal mortality ratio of 460 per 100 000 live births, due to obstetric complications, makes it one of the highest in Africa[5]. Although the country spends 8,4% of GDP on health, the density of healthcare workers (nurses and doctors) per 1 000 of the population is low[5].

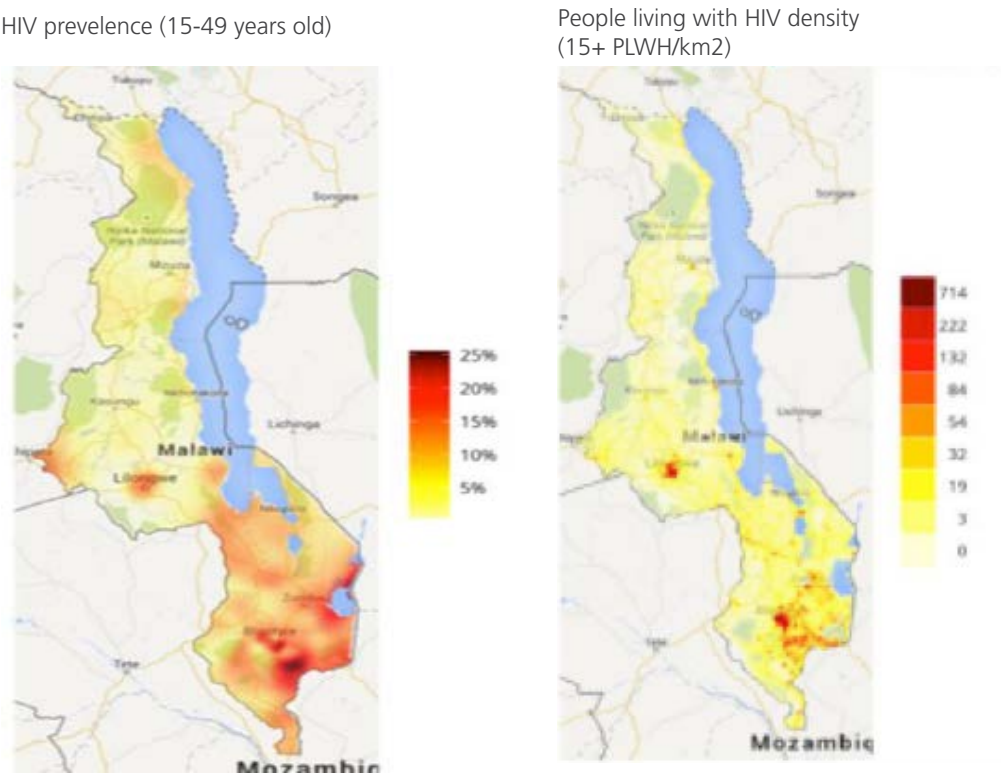
Mining Landscape

The small mining industry contributes about 2,3% to the country's GDP. Government has planned large countrywide geological surveys to increase knowledge of available minerals to grow mining's contribution to GDP to 20% by 2023, as the country moves away from an agro-based economy[6]. Some of the government's objectives include promoting artisanal and small-scale mining, increasing involvement of women in the mining industry, and fostering economic diversification[6]. Known mineral resources in Malawi include uranium, heavy mineral sands, limestone, precious stones, sulphides and coal[6]. An artisanal and small-scale mining training center has been established in Mzimba district, in the Northern region[7].

■ **Figure 5.3**

Prevalence of HIV and density of PLWH in Malawi

[Source: Malawi AIDs Response Progress Report]



Malawians used to make up a significant portion of South Africa's mining labour force in the 1970s and 1980s, but between 1988 and 1992, about 13 000 migrant miners were repatriated to Malawi. This was because 200 miners tested HIV positive and the Malawian government refused to screen all men for HIV before they returned for work in the mines[8]. Only a few Malawians still work in South African mines. There is, however, little information about where the miners were based within Malawi.

Results

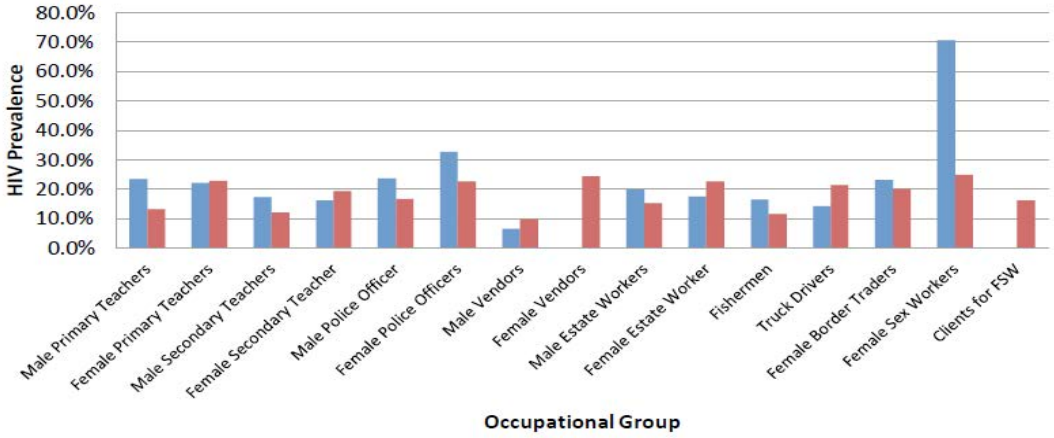
General Population: TB and HIV Epidemiology

Around 980 000 people are living with HIV in Malawi, and the prevalence is estimated at 9,1% among people aged 15-49 years[9]. Women bear the brunt of the HIV epidemic: the percentage of men with HIV is 45% versus 55% of women. Around 540 000 women are infected with HIV. The prevalence of HIV in the age group 15-49 years has been declining over the years, from 16,4%

■ **Figure 5.4**

The prevalence of HIV in high risk individuals in Malawi

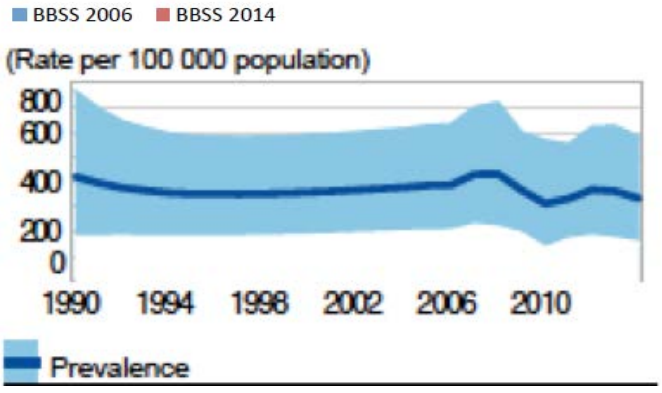
[Source: Malawi AIDS Response Progress Report]



■ **Figure 5.5**

TB Prevalence in Malawi

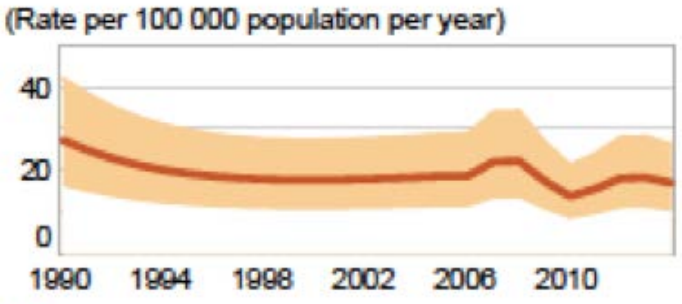
Source: World Health Organization



■ **Figure 5.6**

Rate of Mortality in Malawi

Source: World Health Organization



in 1999 to 11,8% in 2004 and 10,6% in 2010. The HIV prevalence was also observed to be higher among certain occupational groups, like female sex workers (70%), female police officers (31%) and truck drivers (22%), as illustrated in Figure 5.4. Mine workers have not been described as one of the occupational groups at high risk of HIV infection[9].

The TB burden in Malawi (Figure 5.5) is slightly lower than the other Sub-Saharan countries, with in an incidence of 227 per 100 000, and prevalence of 334 per 100 000[10]. The proportion of MDR TB cases is 0,42%[10]. Mortality due to TB is 17 per 100 000, (Figure 5.6) while mortality due to HIV and TB only is 42 per 100 000[10]. A total of 93% (16 445) patients were tested for HIV in 2014; of these, 54% (8 844) were HIV infected, and 92% (8 162) of people co-infected with HIV and TB were already receiving antiretroviral treatment[10]. There are 42 centers in Malawi able to perform Xpert MTB/Rif testing[10]. The TB prevalence is higher in males compared to females (8 724 cases in males vs. 5 716 in females) across various age groups[10]. As shown in Table 5.2, the most affected male age groups are 25 years to 54 years[10].

District reports from the Ministry of Health in Malawi on some of the districts show the number of notified cases of TB per district is reducing slightly, comparing 2011 to 2015 (Table 5.3). The highest number of TB cases was reported from Lilongwe. TB incidence could not be estimated for all the districts as district-level population numbers could not be accessed. The northern districts that are known for mining reported some of the lowest TB cases: 242 in Karonga and 139 in Rumphi (Table 5.3).

Table 5.2 Notified cases per 100 000 of TB in Malawi by age in years and gender.
[Source: World Health Organization]

Age	0-4	5-14	15-24	25-34	35-44	45 -54	55 - 64	>65
Female	24	22	57	150	206	186	143	127
Male	30	23	55	229	341	321	274	273

Table 5.3 Notified cases of TB per district from 2011 – 2015 *Received report from Ministry of Health Malawi*

District	2011	2012	2013	2014	2015
CHIRADZULU	1094	808	649	523	467
DEDZA	394	424	432	457	447
KARONGA	213	242	213	230	242
KASUNGU	318	282	258	208	208
LILONGWE	4940	4955	4257	4172	4166
MANGOCHI	871	912	1058	837	877
MCHINJI	311	355	290	316	315
MWANZA	322	191	304	283	334
MZIMBA	865	878	1019	1047	983
NENO	190	183	180	158	173
NTCHEU	354	453	375	316	272
PHLOMBE	483	469	420	136	259
RUMPHI	198	169	155	106	139
Total	**12 564**	**12 333**	**11 623**	**10 803**	**10 897**

Published Literature

Published literature from Malawi does not report on the health status or health issues of miners based in Malawi. A great deal of literature covers HIV, TB and silicosis for miners working in South Africa. Findings from studies done in South Africa could be applied to migrant Malawian miners.

HIV prevalence is highest in Thyolo (21,6%) Mulanje (19,9%), Chiradzulu (19%), Nsenge (18,5%), Blantyre (17,8%) and Neno (17,5%) as shown in Table 5.4. The northern districts that have mining activity have some of the lowest, for example Chitipa has an HIV prevalence of 4,4% in people aged 15-49 years.

Perception of Key Iinformants

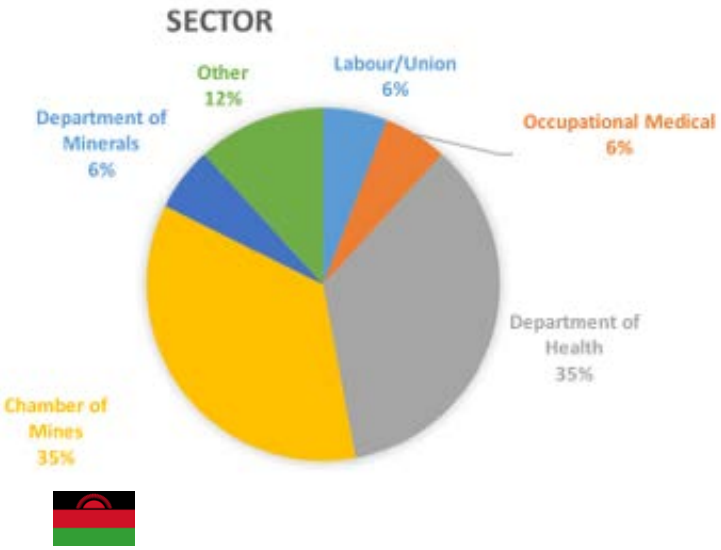
Population Description

A total of 21 key informants for Malawi were interviewed. They were from different sectors of employment: Department of Health (6), Chamber of Mines (6), Department of Mineral Resources, Department of Labour (1) and other sectors (2) (Figure 5.7). Most of the key informants were aware of open pit, quarrying and underground mining as the type of mining found in Malawi. A high proportion of informants reported Lime Company, Kaziwiziwa, Mchenga and Kayerekera to be the top mining companies. Based on the interviews, the commodities mostly mined are coal and uranium.

■ **Table 5.4** Prevalence of HIV in various districts of Malawi

District	HIV Prevalence in 15-49 years old	District	HIV Prevalence in 15-49 years old
Balaka	13,80%	Mzimba	6,30%
Blantyre	17,80%	Nchinga	10,30%
Chikwawa		Neno	17,50%
Chiradzulu	19,00%	Nkata Bay	9,60%
Chitipa	4,40%	Mkhotakota	5,90%
Dedza	8,20%	Nsanje	15,50%
Dowa	8,20%	Nsenge	18,50%
Karago	10,70%	Ntcheu	2,90%
Kasunga	5,30%	Ntchisi	4,80%
Lilongwe	9,50%	Phalombe	17,50%
Machinga	13,30%	Rumphi	6,70%
Mangochi	11,80%	Salima	10,70%
Mulanje	19,90%	Thyolo	21,60%
Mwanza	11,60%	Zomba	

■ **Figure 5.7**
Sectors of employment for the Key Informant Figures



Health Systems

Some (38%: 6/16) of the informants stated that current miners and ex-miners access health services at the state hospitals like the general population. Others (2/16) indicated that some mines have clinics that offer pre-medical screening to their employees. The health services provided are limited to minor illness. Treatment for diseases such as TB and HIV are only accessed at state hospitals. Informants also stated that TB is not considered an occupational disease. Informants perceived the health system to be inadequate as there are shortages of health-care workers. Some state hospitals do not have the data collection tools to record occupational details of patients, so that current miners and ex-miners are treated like general patients. As a result, occupational diseases are sometimes overlooked.

"We don't have a clinic here and our miners undergo general medical and physical check-up at health centre or depending on the disease may go to the district hospital."

(KI081, Mmining Industry)

Legislation

Key informants stated that up to three months paid sick leave is given to employees declared sick by a qualified health practitioner. Other informants (16/17) stated that health and safety laws exist for miners based in Malawi. However, most informants stated that the regulation mainly focuses on the safety of miners (such as requirements for protective clothing and equipment and safe environments) and there is little about the health aspects of miners in the legislation.

"Occupational Health and Safety, that is for employees in all sectors and covers in the mines. It's just general ..."

(KI078, Department of Labour)

Despite requests to review and update the legislation, which was published in 1981, this has not yet been done. Some (4/5) of the informants mentioned that the legislation is partially followed. Malawi has no compensation system for TB, MDR-TB, HIV and silicosis. However, there is a compensation system for work-related injuries, and occupational hazards such as hearing loss and blindness.

"I know only for injuries, while diseases like TB, MDR TB. Silicosis and other occupation diseases are not currently covered in our compensation system".

(KI081, Mining Iindustry)

TB prevalence

One informant stated that the mining industry in Malawi has been underdeveloped and it has only been formalised recently. Hence, most informants stated that they do not have much information about TB among miners.

"We know that miners have high risk of developing TB due to the dust but fortunately we have had no cases."

(KI081, Mining Iindustry)

Informants claimed to know more about ex-miners who worked in the neighbouring countries rather than current miners in Malawi. Nevertheless, participants are aware that miners are at a high risk of being infected with TB due to their working environment. Yet they maintain that Malawi does not have an alarming rate of TB cases among miners. One informant stated that they would like to see more research on TB among miners.

Summary of key findings

Malawi is low-income country, whose economic mainstay is agriculture. The population is young, with only 4,9% of people above the age of 65 years, and most people (80%) live in rural areas. Communicable disease like TB, malaria and HIV are major causes of morbidity and mortality. The HIV prevalence in people aged between 15-49 years is 9,1%, and the TB incidence is 227/100 000, with 0,42% being MDR-TB. The HIV and TB disease prevalence is lower in the Northern region where the mines are located. A few mining companies provide primary health care services for employees, with a focus on injuries and common infections like malaria.

Data gaps and limitation

There are no studies or reports on health status of mine workers and their communities in Malawi. All the published reports are based on health issues for the general population.

Conclusion

Despite some improvements in millennium development goal targets, both child and adult mortality remain high due to an enormous burden of diseases such as TB, HIV, and malaria and the increasing prevalence of non-communicable diseases. Private healthcare plays a significant role as it provides 40% of all health services and most private health facilities are in rural areas. HIV prevalence is estimated at 9,1% in the 15-49-year age group, and it varies greatly by district, with the highest prevalence in Thyolo (21,6%) and the lowest in Chitipa (4,4%).

Recommendations

Mining districts in the northern region of Malawi have the lowest prevalence of TB in the country. Although there is no data on mine workers specifically, miners have not been described as high-risk occupational group like teachers and policemen. The focus of Occupational Health Services should be directed at miners that used to work in South Africa. Recommendations for Malawi include:

- Improve surveillance and health-status reporting on miners and their communities.
- Strengthen the health system to be able to deal with the increasing prevalence of non-communicable diseases in the context of high prevalence of communicable and tropical diseases.
- Include management of tropical diseases in occupational health services.
- In providing additional health services, take into consideration the role private health care performs.

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An estimated four-million people have worked in South African mines over the years, and half of them are still alive today, with around 147 000 coming from Mozambique.

Chapter 6: **Mozambique**

Executive summary

Background: Mozambique is a Portuguese speaking low-income country with a population of 25 million people. Mining contributed 3,5% to the country's GDP in 2010 and employed less than 1% of the workforce who are mainly involved in artisanal and small-scale mining. The country has been a major source of labour for South Africa's mines with approximately 4 million Mozambican's engaged in migrant mine work in South Africa through the years.

Key Findings: The TB prevalence reported in 2014, of 554 per 100 000 population, is one of the highest in the world. For those infected with TB 3.5% have MDR-TB. HIV prevalence is estimated at 10.5% for people aged 15-49 years, yet less than 15% of those infected are on treatment. Miners and their partners have higher HIV rates compared to the national average. An overall HIV prevalence of 22.3% was reported amongst migrant mineworkers in 4 provinces (Inhambane, Gaza, Maputo, Maputo city).

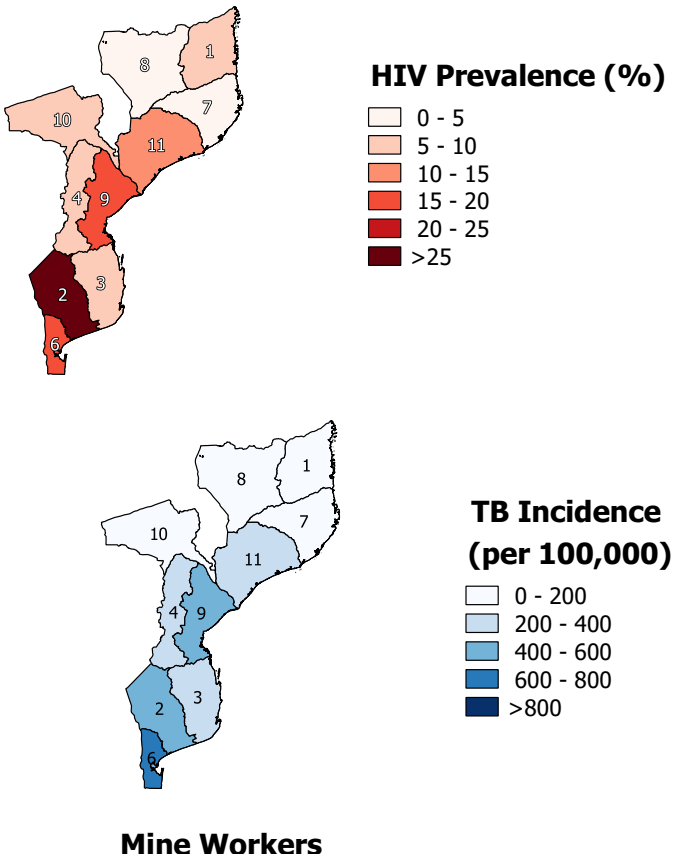
Limitations: No verified data on TB rates or silicosis in miners is available. No information is available on miners employed in the Mozambican mining sector. We did not receive Ethics Approval from the Mozambican government to carry out research amongst key industry informants.

Recommendations: Up-scaling the rollout of ARV's is a key priority. Primary research studies and surveillance systems need to be initiated to assess miners and miners health needs in Mozambique

■ Figure 6.1

Estimated TB incidence in mine workers in Mozambique

ID	Province
1	Cabo Delgado
2	Gaza
3	Inhambane
4	Manica
5	Maputo City
6	Maputo
7	Nampula
8	Nassa
9	Sofala
10	Tete
11	Zambezia



Introduction

Mozambique is a low-income country in the southern part of Africa whose long Indian Ocean coastline is popular for great beaches[1]. The estimated population is 25-million, 45% of whom are below the age of 15 years, while 5% are above 60 years[1]. The capital city is Maputo, which is surrounded by the Maputo province, but administered as a separate province, Cidade de Maputo. The official language in Mozambique is Portuguese[2]. The country is divided into 11 provinces as shown in Figure 6.2 and Table 6.1. Each of the provinces is further divided into health districts, and there are a total 142 health districts in Mozambique[2].

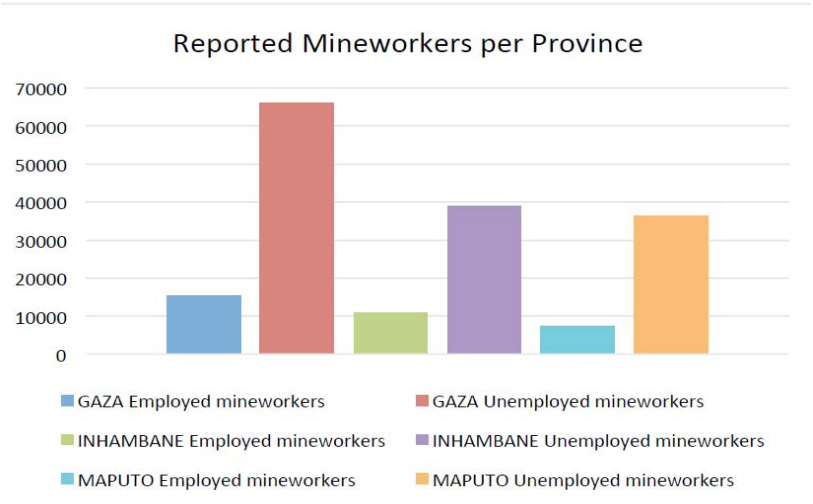
The health districts that have mining activities or miners that work in South Africa include Mandlakaze or Manjacze, Chibuto Xai-Xai, Cidade de Matola and Cidade de Maputo[3]. More than half (54%) of the population lives below the poverty line and several strategies have been developed to reduce poverty[4]. The country is ranked 185 out of 186 countries on human development[4]. GDP growth has declined from an average of 7% a year in the last 10 years to 6,3% in 2015 due to reduction in foreign investment, low public expenditure and lower export earnings [5]. Although the urban population is growing, it represents less than a third of the total population[5].

Table 6.1 Mozambique population by province and number of hospitals and clinics *[Available from Africa]*

Site	Population size	Number of Hospitals	Number of Clinics
Country			
Mozambique	27216276	46	
Provinces			
Cabo Delgado	1 923 300	4	
Gaza	1 442 100	5	123
Inhambane	1 523 600	3	125
Manica	2 001 900	2	
Maputo	1 782 400	3	82
Nampula	5 130 000	5	
Niassa	1 722 100	2	
Sofala	2 099 200	5	
Tete	2 618 900	6	
Zambézia	4 922 700	6	

Figure 6.2
Map of Mozambique

Figure 6.3
Reported Mineworkers per Province in Mozambique according to TEBA data
[Source: URC Mapping Exercise Mozambique]



General health indicators

The health system is supported through three models, public, private for profit and private for non-profit. The public sector is the main health service provider, catering to the needs of approximately 60% of the population[6]. Some movement has been made towards meeting some of the health-related millennium development goals. Neonatal mortality has reduced to 30/1 000 deaths and the under-five mortality rate has been reduced to 90/1 000, yet there are still several poor health outcomes[6]. Life expectancy at birth is 53 years[6].

Malaria accounts for about a quarter (26%) of all hospital deaths. Dual infections with HIV and TB and the increasing prevalence of multi-drug resistant TB continue to challenge the national TB control program[6]. The health care system in Mozambique is further compromised by inadequate financing, shortage of trained health care providers and inadequate geographic coverage of health services[6]. The country has 0,03 physicians and 0,34 nurses per 1 000 population[6].

Mining landscape

An estimated four-million people have worked in South African mines over the years, and half of them are still alive today, with around 147 000 coming from Mozambique[7]. Gaza province is the largest labour-sending source in the country (Figure 3), with 15 399 employed mine workers and 66 050 unemployed mineworkers. Inhambane province is the second largest with 10 855 employed mineworkers and 38 934 unemployed mineworkers; and finally, Maputo is third largest, with 7 315 employed mine workers and 36 353 unemployed mineworkers[7].

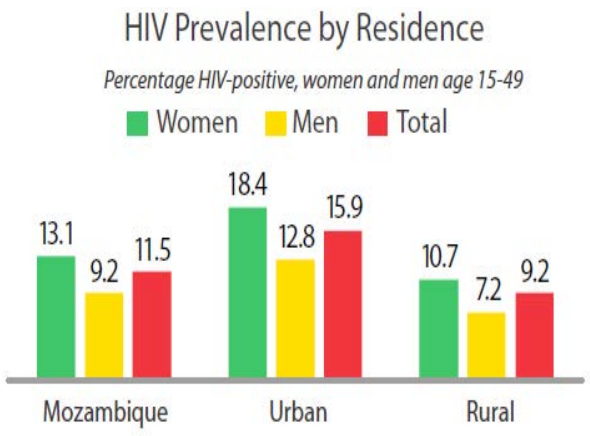
Tables 2A – to Table 2C summarize the distribution of miners (both current and ex-mineworkers) in each of the three provinces (Gaza, Inhambane and Maputo). The proportions given in column three of each table represents the proportion of miners in that province that reside in a district. Within the Gaza province, Xai-Xai has the most miners (26 419; 32%), followed by Chibuto (18 480; 22,7%), Limpopo (10 879; 14,1%) and Mandlakazi (11 707; 14,4%)[7]. The districts with the most miners in Inhambane province are Massinga (14 860; 30%), Zavaia (7 861; 15%), Homoine (7 394; 15%) and Murrumbene (5 179; 10%)[8]. Maputo city has the highest percentage of miners with 56% (24 419) residing there, but it also has the highest number of healthcare facilities[7]. In summary the top four districts with the most mineworkers are Xai-Xai, Maputo city, Chibuto and Mandlakazi, and the one with the least healthcare facilities is Chibuto[7].

Results

General Populateion: TB and HIV Epidemiology

A total of 1,5-million people are living with HIV in Mozambique, and the prevalence is estimated at 10,5% among people aged 15-49 years[7]. Women bear the brunt of the HIV epidemic, with 830 000 infected with HIV, and even comparing by place of residence (rural vs. urban) and within each province, women more than men are affected (Figure 6.4 and 6.5)[8]. The overall HIV prevalence in women is 13,1%, and 9,2% in men between the ages of 15-49 years[8]. Women also become infected at younger ages (peak at 25-29 years; 16,8%) than men (peak at 35-39 years; 14,2%) (4)[8]. HIV prevalence is highest in Gaza, Maputo province, Maputo city, Manica and Sofaia[8].

■ **Figure 6.4**
HIV Prevalence by Residence
[Source: INSIDA 2009]



■ Table 6.2 Distribution of current and ex-miners in three provinces in Mozambique

2 A:Gaza mine workers distribution

Population of Mineworkers and Ex-Mineworkers			
District	Total Number	%	Total Number of Health Facilities
Xai-Xai	26 419	32%	21
Chibuto	18 493	22,7%	15
Mandlakazi	11 707	14,4%	20
Limpopo	11 518	14,1%	34
Bilene	9 371	12%	11
Guija (Canicado	3 635	4,4%	8
Other	306	0,4%	26

2 B: Distribution of Inhambane mineworkers

Population of Mineworkers and Ex-Mineworkers			
District	Total Number	%	Total Number of Health Facilities
Massinga	14 860	30%	13
Zavala	7 681	15%	12
Homoine	7 394	15%	13
Morrumbene	5 179	10%	10
Inharrime	3 274	7%	10
Vilanculos	2 795	6%	10
Inhambane City	2 066	4%	8
Maxixe	1 949	4%	12
Panda	1 783	4%	5
Govuro	1 205	2%	7
Jangamo	1 199	2%	7
Other	404	1%	10

2 C: Distribution of mineworkers in Maputo city and Maputo Province

Population of Mineworkers and Ex-Mineworkers			
District	Total Number	%	Total Number of Health Facilities
Maputo	24 264	56%	42
Matola	8 239	19%	16
Manhica	4 565	10%	16
Magude	3 145	7%	7
Moamba	1 901	4%	9
Marracuene	943	2%	6
Other	611	1%	30

[Available from: URC Mapping exercise Mozambique]

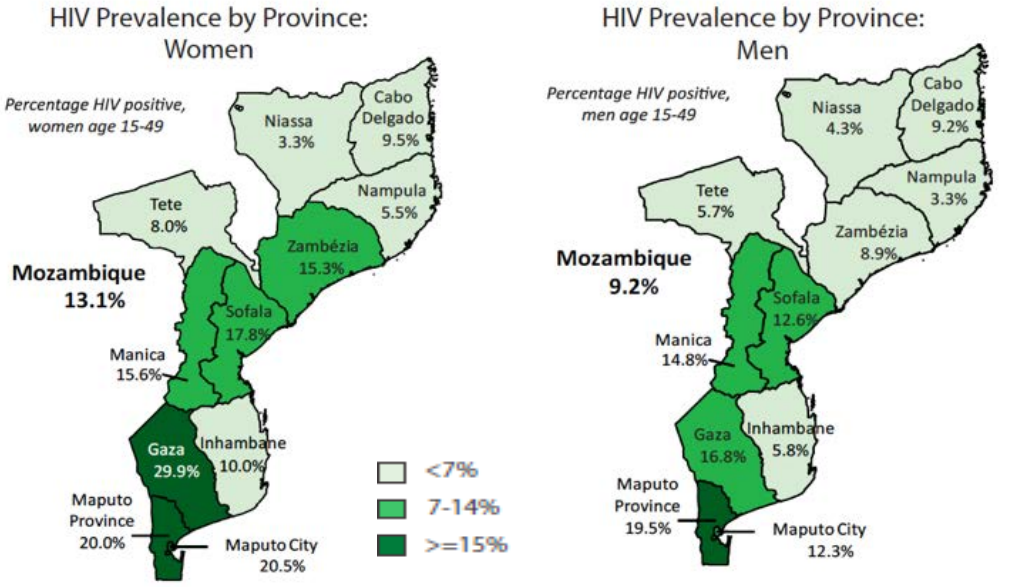
In males and females, HIV prevalence is higher among those that are educated, widowed or divorced/separated[8]. Although there is government and international donor support for the ARV program in Mozambique, national treatment coverage remains low, with less than 15% of people living with HIV and eligible for ARVs not yet on treatment[9]. In areas with high HIV prevalence like the Zambezia province mobile clinics have been used as innovative approach to expand ART services[9].

Mozambique is regarded as one of the countries with the highest TB prevalence. The estimated TB prevalence in 2014 was 554/100 000 (Figure 6.10)[6]. The TB incidence is 551/100 000 (6.6)[10]. Mortality due to TB is 134/100 000 (Figure 4); and 3,5% of TB patients have multi-drug resistant TB[10]. A total of 96% (55 943) of TB patients were screened for TB in 2014, and 52% of them were found to be HIV positive; of these HIV positive TB patients, 81% (23 801) were already taking antiretroviral medication[10].

■ **Figure 6.5**

HIV Prevalence by province in women and men

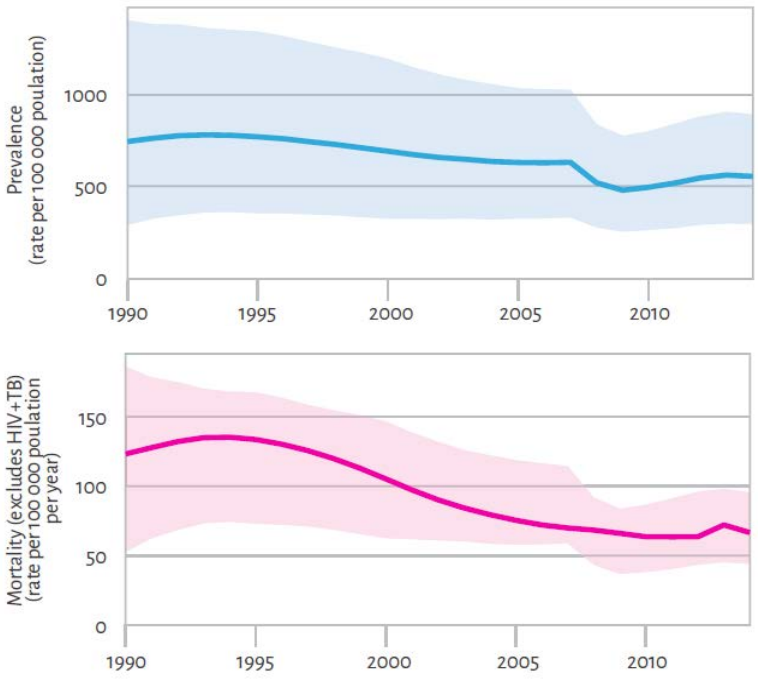
[Available from INSIDA 2009]



■ **Figure 6.6**

Estimated TB prevelence rate (blue) and TB maturity rate (pink) per 100 000

[Source: WHO TB Report, 2015]



Published literature

The literature search found a total of four publications describing issues of miners' health in Mozambique (Table 6.3). Most of the articles published are recent, 2010-2015, and three are looking at miners who are from Mozambique and working in South Africa.

Data Challenges

Information on miners and their partners' HIV prevalence is limited. Those publications that are available are recent. Furthermore, there is no published data on TB and silicosis in miners in Mozambique. Also, little information is available on miners who work in Mozambique.

1. *In a study by Martins-Fonteyn et al* (2015), the HIV prevalence in miners from Chokwe (capital city and economic hub of Gaza province) was 42%[11], which is much higher than the general HIV prevalence of 16,8% in males in Gaza province[8].
2. *Cremin et al (2015)* found that the HIV prevalence of partners of miners in Gaza is also higher than the general population[12].
3. *In another study, Baltazar et al. (2015),* that included the top four provinces that have miners working in South Africa, HIV prevalence of miners was also recorded as higher than the general male population HIV prevalence in all the four provinces[13]. The miners' HIV prevalence was comparable to the reported HIV prevalence of the districts where they work in South Africa[13]. Only one in four (25,4%) HIV positive miners had previously tested and knew their status[13].
4. *In a qualitative study with current miners by Crush et al. (2010),* it was further highlighted that labour migration adds an additional risk factor for vulnerability in acquiring HIV[14]. There were no studies published on miners' TB disease and silicosis in Mozambique.

■ **Table 6.3 Summary of published literature on miners' health in Mozambique**

YEAR	METHODOLOGY	RESULTS	COMMENTS
2015 Martins-Fonteyn et al.	Cross-sectional study of current miners from Chokwe District employed in South Africa gold, platinum, coal, silver, chromium mines.	42% Reported HIV Prevalence in Chokwe (capital city of Gaza Province) miners Risky behaviour like alcohol consumption and low level of perceived risk of HIV was associated with HIV infection	
2015 Cremin et al.	Modelling studies of miners and partners of miners from Gaza.	**HIV Prevalence:** 26% miners **HIV Incidence:** 3,2% - 4% (partners of miners)	Providing time-limited PrEP to partners of migrant miners in Gaza Province during periods of increased exposure would be a novel strategy.
2015 Baltazar et al.	Cross-sectional study of current miners from Inhambane, Gaza, Maputo, Maputo city, working in South Africa	**Overall HIV Prevalence:** 22,3% (17,8%-26,9%). **HIV Prevalence Mozambique province:** Maputo city (27,4%: 16,3%-38,5%). Gaza (26,1%: 18,7%-33,6%). Inhambane (14,7%: 8,2%-21,1%). **HIV Prevalence in province of residence in South Africa:** North West (21,7%: 15,8%-27,7%). Gauteng or Free State (25,6%:16,5%-34,6%). Other (18,2%: 6,8%-29,6%)	Nearly three quarters (74,6 %) of HIV-positive mineworkers were not aware of their status. The prevalence of HIV among Mozambican miners working in South Africa was higher than the general male Mozambique population.
2010 Crush et. al.	Questionnaires with current miners	This study has confirmed that mobility and vulnerability are intimately connected. It has also suggested that the causes and consequences of vulnerability of migrants and their partners are closely connected.	

Conclusion

Mozambique is a low-income country that has had an economic growth decline in the last year, and 54% of the population lives below the poverty line. Although some health outcomes have improved, the health system is still challenged with high prevalence of TB, shortage of skilled health-care workers and inadequate coverage of health services. The country has been ranked among those with high TB prevalence (>500/100 000). The districts that have the most miners are Xai-Xai, Chibuto, City of Maputo and Manakazi. The HIV epidemic has affected women more than men. Miners and their partners have higher HIV prevalence compared to the general population. Although there is no data specifically addressing TB in miners, it would be expected to be high as they have a history of working in the mines and high HIV prevalence. Augmentation of the occupational health services should be focused on the four districts with the most miners, and include increasing access to HIV services (test and treat) and TB screening, diagnosis and treatment.

Recommendations

- Undertake more research, surveillance and reporting on miners' health in Mozambique
- Focus interventions to address miners health issues (occupational health services) on the four top districts: Chibuto, city of Maputo, Xai-Xai and Mandlakazi.
- Offer HIV and TB prevention services to miners and their partners.
- Increase access to the antiretroviral programme, as only 15% of the people eligible for treatment have been initiated on ARVs.

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Namibia is ranked among the top 10 diamond producers in the world, and produces 5% of the world's uranium. However, diamond and uranium mining are not labour-intensive and have little impact on job creation.

Chapter 7: Namibia

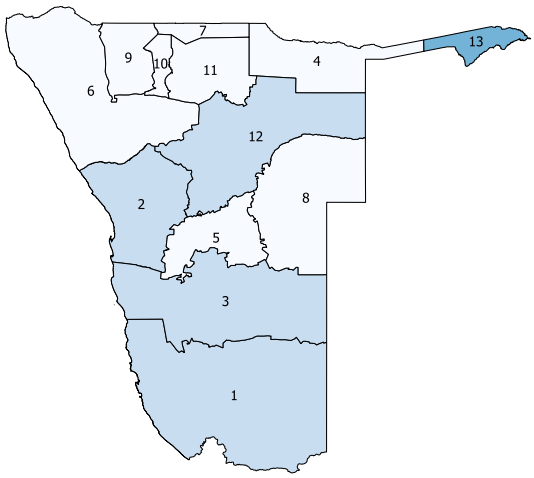
EXECUTIVE SUMMARY

Background: Namibia is a sparsely populated upper-middle income country in South West Africa with a population of 2.2-million people. The growing mining industry is mainly concentrated on diamond and uranium mining. The mining industry in Namibia contributed 11,5% of the national GDP in 2015. The industry employs 2% of the overall labour force of the country, with 17,3% of these people employed in artisanal small-scale mining and quarrying activities.

Key Findings: Namibia is one of the high TB burden countries with an estimated prevalence of 627 per 100 000 in 2015. Of the the newly diagnosed cases 3,8% have MDR-TB. Overall HIV prevalence is 16% but the incidence rates have been on a downward trend due to improved ART coverage. The highest TB prevalence rates have been reported in mining areas (1 000-1380 per 100 000), however, no data on actual TB rates in mineworkers is available. In mining areas higher than average HIV prevalence rates of 20 – 25% have been reported. A Zinc mine in southern Karas region had an HIV prevalence of 25% amongst its workforce in 2007.

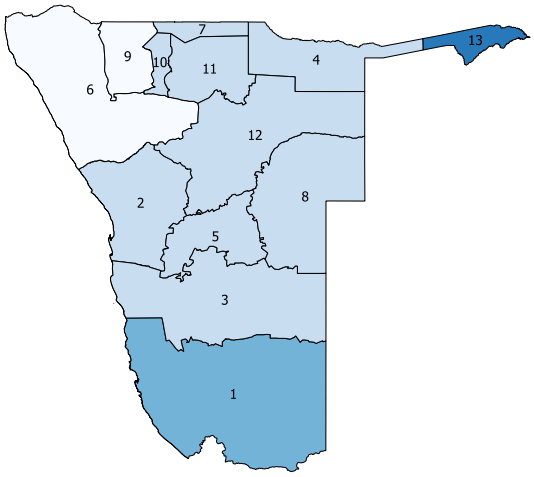
Limitations: Specific information on HIV, TB or silicosis rates in miners is not available.

Recommendations: Primary research studies and surveillance on mineworkers need to be conducted. Expansion of health facilities that have occupational health services in remote areas.



ID	Name
1	IKaras
2	Erongo
3	Hardap
4	Kavango
5	Khomas
6	Kunene
7	Ohangwena
8	Omaheke
9	Omusati
10	Oshana
11	Oshikoto
12	Otjozondjupa
13	Zambezi

General Population



Mine Workers

TB Incidence (per 100,000)

- 0 - 200
- 200 - 400
- 400 - 600
- 600 - 800
- >800

Figure 7.1

TB incidence in general population and estimated TB incidence in mine workers in Namibia

Introduction

The Republic of Namibia is situated in south west Africa with a coastline on the Atlantic Ocean. Namibia shares borders with South Africa to the south, Zambia and Botswana to the east and Angola to the north (Figure 7.2). Namibia is the second-least densely populated country in the world[1] with an area size of 824 292 km^2. The country is divided into 14 regions and subdivided into 121 constituencies[2]. The 14th region was added in 2013 with the splitting of the Kavango region into Kavango East and Kavango West. The capital city, Windhoek, is in Khomas region. Namibia's population was estimated at 2 212 307 million in 2016. According to the 2011 national census, the Khomas region is the most densely populated, with an estimated population of 342 141 (Table 7.1)[3].

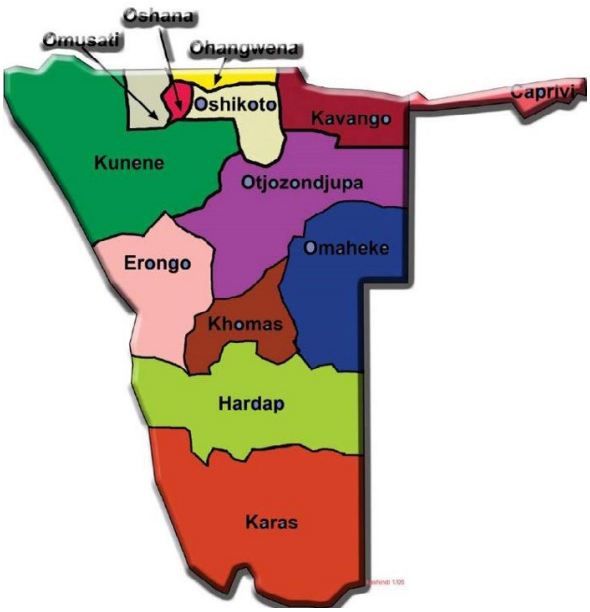
Namibia is an upper-middle income country and its GDP per capita is $6 014[4]. The country's economy grew by 5,6% a year between 2010 and 2014[5]. The main industries in Namibia are tourism, mining, agriculture and herding. A contraction in the mining industry and the ongoing drought have led to a slowdown in economic growth for 2016[6]. Although Namibia is classified as an upper-middle income country, it has a poverty incidence of 26,9%[7]. There are large discrepancies in income level, standards of living and quality of life across the different regions and constituencies, mainly because of past exclusionary economic policies. Namibia has an unemployment rate of around 29,6%.

General health indicators

Health care in Namibia is provided largely through the public sector (85%) with only 15% of the population using private health care[8]. Total public spending on health care for 2014 was 8,9% of GDP[5]. Despite the higher than average investment in healthcare, Namibia did not reach its MDG targets of improving child and maternal mortality by 2015[9]. The health system suffers from a critical shortage of skilled health-care workers. A total of 343 hospitals and clinics, and 1 150 mobile clinics serve the sparsely distributed population[10]. The public sector has less than two healthcare workers per 1 000 of the population. The high burden of communicable diseases such as HIV/AIDS and TB has had a negative impact on the health profile of Namibia[8]. Life expectancy at birth for males is 63,1 and for females 68,3 years; the maternal mortality ratio is 265 per 100 000 live births; and the mortality rate for children under five years of age is 45,4 per 1 000 live births (Figure 7.3)[11].

■ Figure 7.2

Map of Namibia



■ Table 7.1

Population size by region Namibia for 2001-2011

[Source: Namibia Statistics Agency]

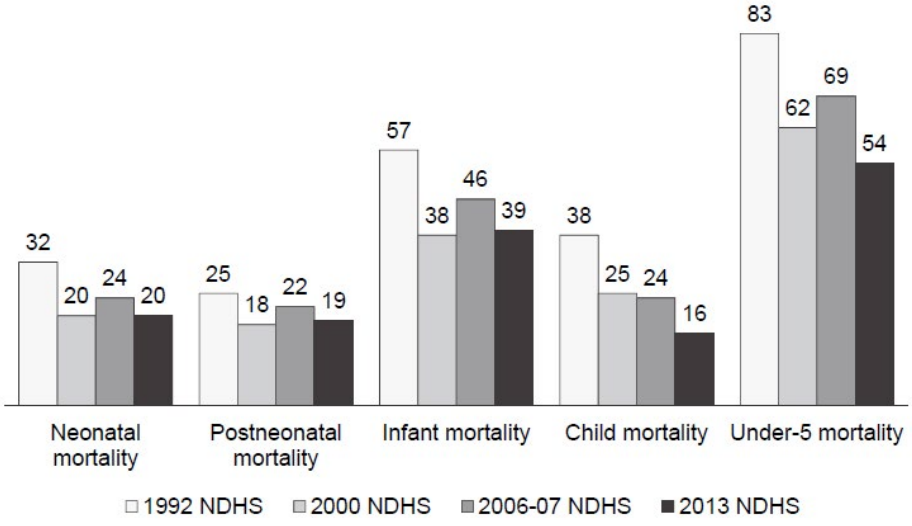
Area	2001	2011
Namibia	1,830,330	2,113,077
Erongo	107,663	150,809
Hardap	68,249	79,507
Karas	69,329	77,421
Kavango E & W	202,694	223,352
Khomas	250,262	342,141
Kunene	68,735	86,856
Ohangwena	228,384	245,446
Omaheke	68,039	71,233
Omusati	228,842	243,166
Oshana	161,916	176,674
Oshikoto	161,007	181,973
Otjozondjupa	135,384	143,903
Zambezi	79,826	90,596

Mining landscape

Namibia's economy is driven by mining and agriculture, with mining accounting for 11,9% of national GDP in 2015[12]. Diamonds and uranium are Namibia's principal mining commodities, followed by copper, magnesium, zinc, silver, gold and lead (Figure 7.4). Namibia is ranked among the top 10 diamond producers in the world, and produces 5% of the world's uranium[13]. However diamond and uranium mining are not labour-intensive and have little impact on job creation. In 2014, mining and quarrying employed 2% of the overall labour force (14 539/712 710); 17,3% of all employed miners work in the informal mining and quarrying sector.[2]

An estimated 5 000-9 000 people work in, or are dependent on, small-scale mining. Most small-scale operations in Namibia are focused on gemstones and semi-precious stones, with many possibilities of improvement within the small-scale mining sector in Namibia[14]. In 2013, the areas with the highest employment of miners were Erongo (5 004) and Otjozondjupa (2 310)[3]. Migrant labourers are primarily from the north, working in uranium and gold mines in central Namibia or diamond and zinc mines in the south[5].

■ **Figure 7.3:**
Trends in Childhood Mortality (%) 1987- 2012
[Source: World Health Organizsation]



■ **Figure 7.4**
Mining by commodity in Namibia from 2007-2012
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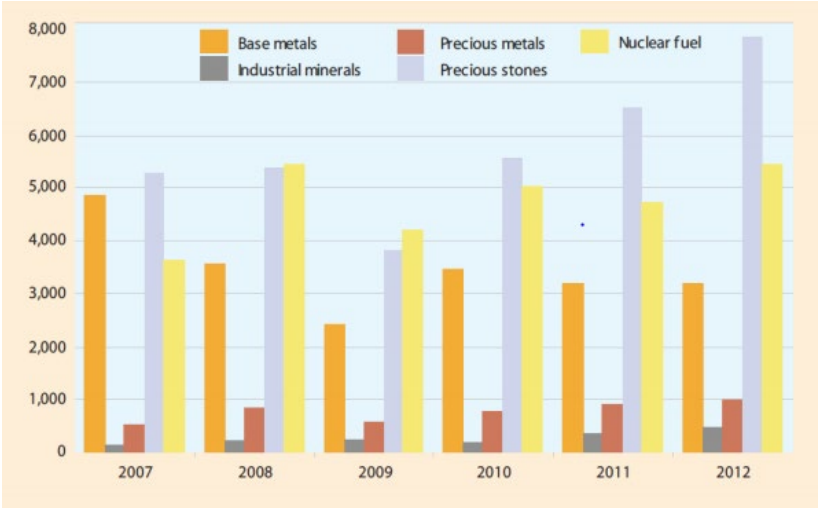
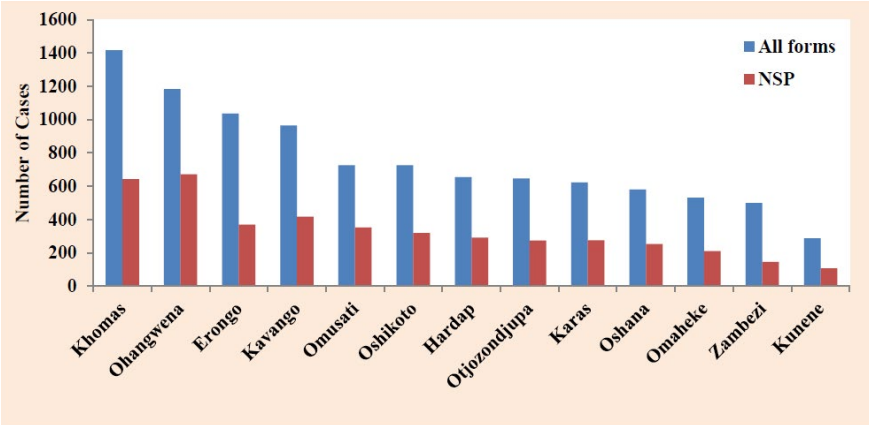


■ **Figure 7.5**

Regional Distribution of TB cases in Namibia (National TB and Leprosy Program summary report 2014-2015)

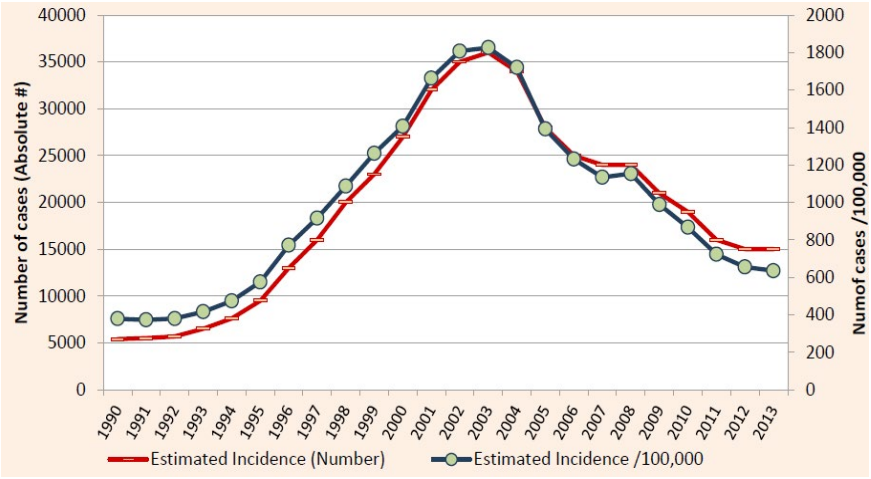
**NSP: New smear positive cases*



■ **Figure 7.6**

TB incidence in Namibia 1990 to 2010

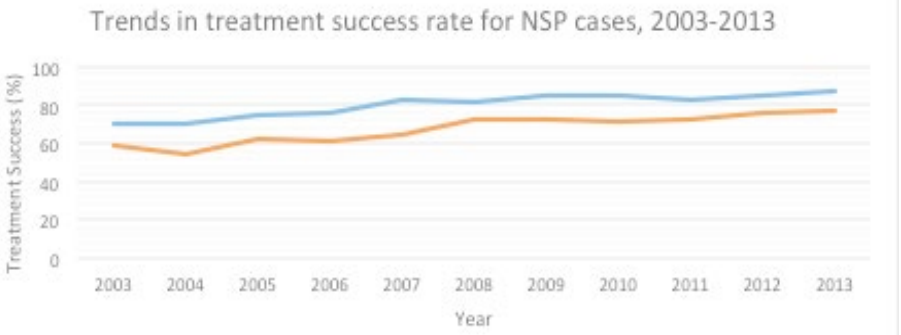
[Source WHO TB country profile, 2015]



■ **Figure 7.7**

Trend in the estimated burden of TB in Namibia, 1990-2013

[Source: Namibia Ministry of Health Report]



■ **Figure 7.8**

Trends in Drug Resistant TB 2007 – 2014

CASE CATEGORY	2007	2008	2009	2010	2011	2012	2013	2014
MDR-TB (excluding XDR-TB)	116	201	275	214	192	206	174	137
Poly-drug resistant TB	7	47	80	63	46	41	19	14
Other rifampicin resistant							103[1]	206[2]
XDR-TB	3	20	17	8	2	4	6	6
Total number of DR-TB cases	**126**	**268**	**372**	**285**	**240**	**251**	**302**	**363**

Results

General Population TB and HIV Epidemiology

Namibia is among the top five countries in the world with the highest per capita TB disease burden[16,17]. The districts with the highest TB incidence are Khomas, Ohangwena, Erongo and Kavango, (Figure 7.5). The prevalence of TB for 2014 was 627 per 100 000 and the incidence rate was 561 per 100 000 (Figure 7.6). The trend in TB case notification has decreased over time following the HIV epidemic trends[10,18](Figure 7.7).

Namibia's TB treatment success rate has been improving steadily and is 87% as of 2013 (Figure7.7). TB and HIV co-infection rates have reduced from 67% in 2006 to 44% in 2014[18]. ARV coverage has increased to 84%[10]. MDR TB rates have remained constant over the past few years (Figure 7.8). In 2014, 3,8% of newly diagnosed TB cases had MDR TB whilst 16% of retreatment cases were diagnosed with MDR TB[17].

There has been a downward trend in the number of new HIV infections reported between the year 2000 (21 000 cases) and 2014 (11 000 cases). HIV prevalence has risen in the general population and is now 16%. This is attributed to increase ARV coverage leading to fewer HIV related deaths. Other factors fuelling the spread of HIV include intergenerational sex, multiple concurrent partners and migration[19]. HIV Prevalence is higher in women than in men, as reported in the Antenatal HIV Sentinel Surveys (Figure 7.9)[20]. Regional HIV prevalence rates vary widely, with the highest rates reported in the Northern districts[7,19]. Women aged 40-44 years are the most affected group, with a prevalence rate of 30,6%, followed by women aged 35-39 years (30,3%)[19]. Namibia has made significant gains in providing access to ARV's for HIV infected people: 81% of adults and 54% of children were on ARVs by 2013/2014[19].

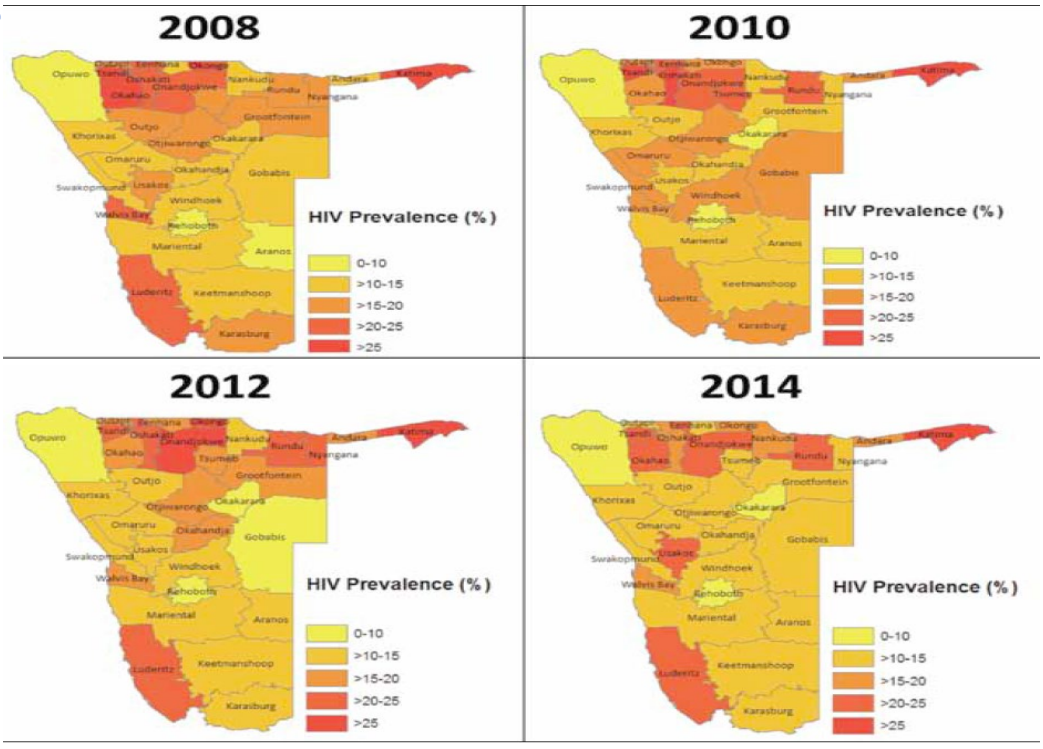
Miners TB, HIV and Silicosis Data

There are no available reports or published literature about the health status of mine workers in Namibia. Erongo region has the third highest TB prevalence in the country and is the site of several mining operations[10]. In 2007, one of Namibia's oldest mines (Rosh Pinah Zinc in

■ **Figure 7.9**

HIV Prevalence by Health District 2008 – 2014 Sentinel Surveys

[Namibia AIDs Response Peogress Report]



the southern Karas region) had an HIV prevalence among its workforce of 24,98%[1].

Published Literature

In 2010, Rukambe conducted a research study with the aim of exploring existing knowledge, attitudes, and practices relating to HIV and AIDS of the workers at the Rosh Pinah Zinc Mine Corporation in Namibia[21]. The study was an exploratory mixed methods research design that distributed questionnaires and conducted one focus group discussion. A total of 123/561 (21,7%) of the miners working at Rosh Pinah Zinc Mine Corporation were enrolled. Most participants had high degree of knowledge of HIV and how to protect themselves from it. The study revealed that over 70% of participants offered non-stigmatising responses towards people living with HIV but few participants were satisfied with the company's HIV programme and many called for more HIV policy content awareness and wellness awareness campaigns (Table 7.2)[21].

Perceptions of Key Informants

Population Description

A total of 11 key informants from Namibia were interviewed: 2 from Oshana, 1 Khomas, 2 from Windhoek, 2 from Erongo, and 1 from Zambezi. The median age of the key informants was 46 years (IQR: 31-67). Key informants were from different sectors, with majority from Ministry of Health and social services (4/11) and others were from the Chamber of Miners (1/10), Department of Mineral Resources (1/11), Mining Industry (2/11), and Labour/ Union (1/11) (Figure 7.10). Therefore, the occupation of the key informants ranged from health professionals, mining coordinators and CEO's. The median duration in the current role of employment was 9 years.

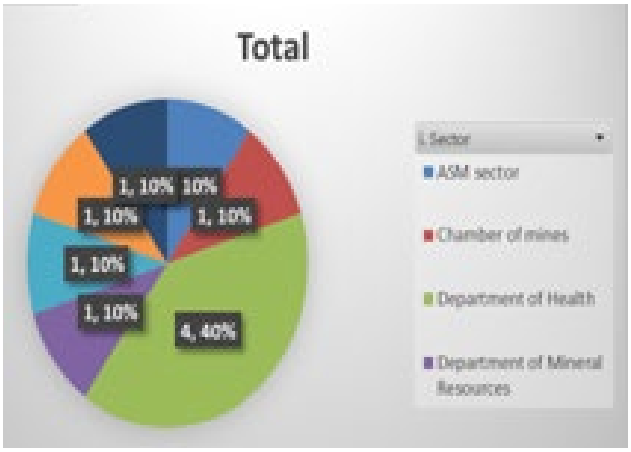
Mining

Overall, key informants were aware of surface mining, quarrying, underground and dredging activities taking place in Namibia. Copper, Diamond and Uranium were perceived to be the most commonly mined commodities in the country. The top five reported mining companies

■ Table 7.2
Summary of Published Lierature on Miners in Namibia

YEAR	METHODOLOGY	RESULTS	COMMENTS
2010. Zelda Rukambe	Mixed Methods (Questionnaire and 1 focus group discussion) with a stratified sample of 123/561 zinc miners		HIV status disclosure remains a problem due to negative connotations; risky sexual behaviour high, with some men having up to three wives, alcohol abuse high, despite high level of knowledge on HIV. Employees would also like more HIV treatment and services for free at the company premises

■ Figure 7.10
Sectors of Key Informants



are Namdeb Holding, Rossing Uranium Mine, Swakop Uranium Mine, Langer Heinrich and Navachab mine (Table 7.3). Most mines are in three regions in Namibia: Erongo, Karas and Hardap.

Health Services

Most key informants were aware of available TB screening, prevention and treatment services offered to current miners, their communities and ex-miners. One informant stated that health services offered to these populations depended on the employer. According to some Key Informants, most mines do not have occupational health clinics, with an exception of Namdeb Holding mines who have hospitals situated at the mines. One Key Informant also reported that the country has mobile clinics that are on site for miners to easily access health services. However, some informants (2/5) stated that miners are normally referred to the nearest health facilities to access TB and HIV services. Key Informants (3/5) indicated that minerworkers based on large scale mines have medical insurance provided by the mining companies. Therefore it is believed that many of them go to private hospitals to access health services. Based on these interviews, doctors and other health professions determine when a miner is ready to go back to work following an episode of TB. Key informants indicated that spouses of miners access the same treatment as mine workers, especially if they ae included in the medical insurance. Challenges arise if the spouse lives apart from the mineworker, then they canaccess health care services through state facilities.

"Each mine has a contract with health practioners. If married they have medical aid with the children included. The mines make sure that the every employee has a medical aid"
(KI111, ASM sector)

Few of the key Informants perceive the health care service available in Namibia to be adequate. One informant stated that in their opinon, in reference to TB, state services are inadequate as there are not any TB focused hospitals in the country to combat TB disease. Majority (4/5) of Key Informants stated that Namibia's health care system allows for contact tracing of TB patients and referral letters are issued to miners wishing to relocate. Key Informants also stated that ex–mine workers receive same health treatment when compared to current mine workers. However, about half of the Key Informants had reported that contract mine workers and current mine workers receive different health services.

Health and Safety Legislation

All Key Informants mentioned that the country has mine health and safety legislation. However, some say that it is partially followed. According to the Key Informants, mine workers are entitled to 20 days of paid sick leave, and majority (7/10) reported that Namibia has an occupational diseases compensation system for sick miners which coveres injuries on duty. Nevertheless, (2/7) informants mentioned that although there is a compensation system, it is a complicated process and there have been complaints about it. Key informants also stated that TB, MDR TB and HIV are not compensated in their country. One informant stated that silicosis is not considered an issue in Namibia and that only injuries such as hearing loss are considered as an occupational illness and are compensated.

"TB, MDR TB are not considered an occupational disease.....silicosis is not an issue in this country"
(KI088, Chamber of Mines)

"They are compensated, there are complaints about the compensation system"
(KI050, Department of Health)

Table 7.3 Perceived top five mining companies

Company	Commoditied Mined
Namdeb Holding Mines	Diamond
Rossing Uranium Mine	Uranium
Swokop Uranium	Uranium
Langer Heinrich	Copper
Navachab Mine	Gold

TB and MDR-TB Prevalence

One informant mentioned that as country, Namibia has no statistics on TB amongst mine workers as there has been no research done on this topic. However, another Key Informant mentioned that according to his/her observation, TB is high in the Erongo and Karas regions., which are mining areas. Some of the interviewed informants are under the impression that there have not been many interventions for ex-miners as they are treated as part of the general population. Some key informants (2/7) mentioned that mine workers are screened for TB prior to being employed and awareness programmes are effective in combating TB among mine workers. On the contrary, one key informant from the Department of Health stated that s/he is more familiar with other respiratory diseases amongst miners other than TB. Majority of Key Informants (5/6) stated that miners have access to TB treatment, across varies sites such as: private facilities, public health facilities, and mine wellness centers. Overall, majority of Key Informants(5/6) perceived the adherence to TB medication to be good. In addition, they stated that they have about 5% defaults and a 85% success rate amongst the general population.

"Currently area of Erongo, Karas TB is very high. Climate is very high, Erongo you do not reduce the sun, bacteria can remain in the atmosphere for a long time... Screening for TB...there is no such areas"
(KI043, University of Namibia)

Very few informants reported on MDR TB. Informants mentioned that miners can access treatment at the public hospitals. All informants perceived adherence to MDR TB treatment to be poor as patient's usually fails to return for treatment.

"MDR TB was not a big problem in Namibia because they are many case of TB, Erongo, Karas they don't have many facilities for MDR TB....."
(KI043, University of Namibia)

HIV Prevelence

Some Key Informants perceived HIV to be high amongst mine workers and their communities. However, one informant argued that HIV is the same as in the general population. Others though, are under the impression that the mines offer annual screening for HIV to their employees. Miners do return to work after being diagnosed with HIV.

"We have not done any study on miners regarding HIV"
(KI051, Department of Health)

"HIV is affecting a lot of miners and communities they work on shifts and the practice behavioural behaviours"
(KI043, Department of Health)

Silicosis

Most of the key informants did not respond to questions relating to silicosis. One informant mentioned that there is lack of education around the issue of silicosis. Another informant perceived silicosis not to be an issue in Namibia because the country only has open pit mines and very few underground mines.

"(silicosis) is not an issue in the country we have mostly open pit mines and only one underground mines"
(KI088, Chamber of Mine)

"Silicosis under estimated and ignored there is no education about silicosis"
(KI043, University of Namibia)

Summary of key findings

Mining contributes 11,5% to the Gross Domestic Product and diamonds are the principal commodity in mining. Small-scale and artisanal mining employs an estimated 5 000-9 000 people. Mining activity stretches across a large part of the country, with pockets of mining in south and central Namibia. Erongo is one of the districts with a high number of active mines. Namibia is a high TB burden country with a TB prevalence of 627 per 100 000. The districts with the highest rates (more than 1 000/100 000) of TB are Khomas, Erongo and Kavango, which are also mining areas. The TB/HIV co-infection rate is more than half (59%) with 84% of HIV positive TB patients on ART. Among the newly infected TB patients 3,8% have MDR-TB. HIV incidence is falling, with 11 000 new cases reported in 2014. HIV prevalence is increasing due to increased ARV coverage and resultant reduction in HIV mortality. Mining districts and labour-sending areas in Namibia reportedly have a higher HIV prevalence compared to the national

average. There is only one study from Namibia and this shows one in four miners is HIV infected.

Data gaps and limitations

Mining contributes a significant amount to Namibia's economy but despite this there is little published research or data on miners' health. There was an inadequate response from Key Informants from whom information could be collected. Information on mineworker's compensation is also scanty.

Conclusion

Namibia is a sparsely populated country with a significant burden of TB disease. The mining industry comprises both formal and small-scale artisanal mining. The trend has been for TB prevalence to show a relative decrease over the years. HIV incidence rates are also declining and HIV treatment coverage has increased. The mining industry's contribution to the TB and HIV burden is currently not known. However, the mining districts have the highest TB incidence and higher HIV prevalence compared to the national average. Data on current occupational health efforts by mining companies is limited. Primary research on TB, HIV and silicosis in current mine workers could assist in filling some of the gaps in knowledge.

Recommendations

- Make the Erongo district the priority area for health services and interventions for miners.
- Undertake primary research to quantify the burden of occupational disease in the mining industry.
- Ensure private mining houses and government co-operate to ensure that safety standards are adhered to and that mineworkers have access to health benefits.
- Strengthen the health system through increasing human resources to serve and remote districts in the country.
- Implement more frequent TB drug resistance surveys.
- In conjunction with the Ministries of Health, expand facilities with the capacity to diagnose and manage MDR-TB.
- Establish an active occupational health institution in the country, which will carry out effective surveillance of miners and ex-miners.
- Review legislation on workers' compensation to ensure that mineworker's needs are covered.

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South Africa is the biggest producer of gold and platinum and one of the main producers of base metals and coal. Gold and coal mining, in particular, are strongly associated with the development of silicosis (8-10 years after exposure) in miners.

Chapter 8: South Africa

Executive Summary

Background: South Africa is the second biggest economy in Africa, with mining contributing 4,9% of GDP. The country has a long history with migrants from across Southern Africa working on its mines. More recently, migrants come mainly from Lesotho, Mozambique and Swaziland. In country, the Eastern Cape and Kwa-Zulu Natal send labour to the mining provinces of Gauteng, North West and the Free State

Key findings: The TB prevalence among miners (3 000 per 1000 000) is three times higher than that of the general population (900 per 100 000). TB rates have increased steadily with the plateauing of the HIV/AIDS epidemic. Additionally, in the gold sector silicosis presents an increased hazard for contracting TB even in the absence of TB. Routine post mortem data shows a silicosis rate of 22% to 32% among miners. However, up to 60% of miners will eventually develop silicosis in their lifetime and these miners are not captured as they migrate back to their provinces or home countries once sick or retired. A new population of illegal miners is increasingly becoming important in the country, however, due to the illegal nature of their activities there is little data available for this population.

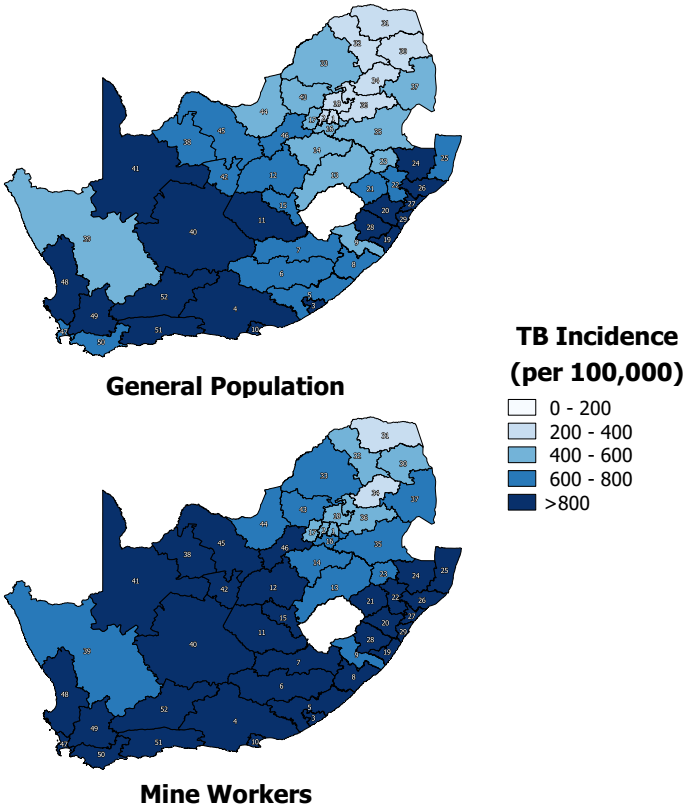
Limitations: There is a paucity of data on small-scale mining. Also, lack of clear guidelines on referral of miners to home provinces or countries impacts on the accuracy of estimates.

Recommendations: An integration of OHS from mines to labour sending provinces or countries will best address TB/HIV and silicosis in South Africa.

Figure 8.1
Estimated TB Incidence in South Africa

ID	District
1	Ekurhuleni
2	Johannesburg
3	Buffalo City
4	S Baartman
5	Amathole
6	C Hani
7	Joe Gqabi
8	OR Tambo
9	A Nzo
10	N Mandela Bay
11	Xhariep
12	Lejweleputswa
13	T Mofutsanyana
14	Fezile Dabi
15	Mangaung
16	Sedibeng
17	West Rand
18	Tshwane
19	Ugu
20	uMgungundlovu
21	uThukela
22	uMzinyathi
23	Amajuba
24	Zululand
25	uMkhanyakude
26	uThungulu

ID	District
27	iLembe
28	Harry Gwala
29	eThekwini
30	Mopani
31	Vhembe
32	Capricorn
33	Waterberg
34	Sekhukhune
35	G Sibande
36	Nkangala
37	Ehlanzeni
38	JT Gaetsewe
39	Namakwa
40	Pixley ka Seme
41	ZF Mgcawu
42	Frances Baard
43	Bojanala
44	NM Molema
45	RS Mompati
46	Dr K Kaunda
47	Cape Town
48	West Coast
49	Cape Winelands
50	Overberg
51	Eden
52	Central Karoo



Country Profile

South Africa is the southernmost state in Africa and borders with Mozambique, Botswana, Zimbabwe, Namibia and Swaziland (Figure 8.2). South Africa has a population of 54-million people (Table 8.1) from diverse ethnic, religious and cultural backgrounds, in nine provinces and 52 health districts. The most populated province is Gauteng and the least populated is Northern Cape. Of the total population, 51% are female and 49% are male[1]. The country has 11 official languages, IsiZulu (22,7%), IsiXhosa (16%), Afrikaans (13,5%), English language (9,6%), Sepedi (9,1%), Setswana (8%), Sesotho (7,6%), Xitsonga (4,5%), siSwati (2,5%), Tshivenda (2,4%) and isiNdebele (2,1%). Official statistics recorded 2,1-million foreign nationals in 2011, but this is likely an underestimation because of undocumented migrants from neighbouring countries[1]. Most of South Africa's population (36,2%) is between the ages of 15-34 years and 30,2% of the population is less than 15 years old[1].

■ **Figure 8.2**
Map of South Africa

■ **Table 8.1 Population by province** *[Source: Statistics South Africa]*

Province	Population Esitmate	% of Total Population
Eastern Cape	6 786 900	12,6
Free state	2 786 800	5,2
Gauteng	12 914 800	23,9
Kwazulu Natal	10 694 400	19,8
Limpopo	5 630 500	10,4
Mpumalanga	4 229 300	7,8
Northern Cape	1 166 700	2,2
North West	3 676 300	6,8
Western Cape	6 116 300	11,3
Total	**54 002 000**	**100**

South Africa is the second biggest economy in Africa and is classified as an upper-middle income country with GDP per capita of $7 575,[24]. However, the unemployment rate is 27,10%[2]. The primary sectors in South Africa are: finance, real estate and business services, manufacturing and government services (Figure 8. 3)[3]. In 2013, mining and quarrying was the 8th biggest sector contributing 4,9% to GDP growth.[6]

General health indicators

The overall health of the country measured against the Millennium Development goals (MDGs) is summarised in Table 8.2 below. Health care in South Africa is decentralised to the 52 health districts. Health varies significantly across provinces (Table 8.3). Similarly, within provinces, health indicators vary by districts. This is because South Africa is an unequal society with a GINI coefficient of 0,7, where 1 represents perfect inequality[4].

■ **Figure 8.3**
South Africa's key sectors: Contribution to GDP growth 2013
[Source: Statistics South Africa]

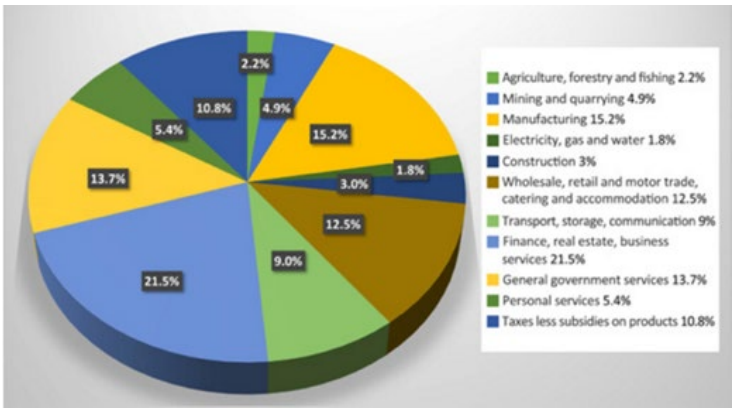


Table 8.2 South Africa progress towards achievement of the health-related MDGs

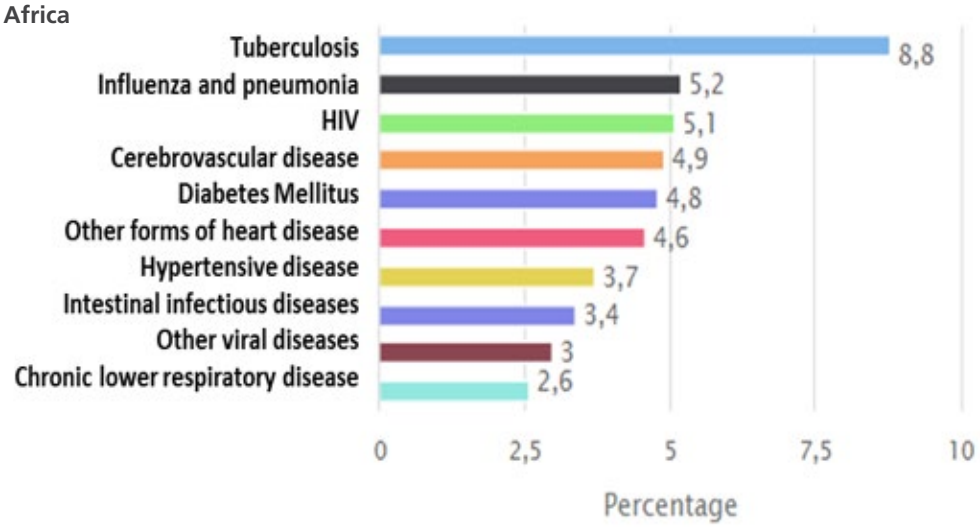
[Source: South African Health Review 2014/2015 (HSRC)]

	Target	Global	South Africa - Status
Target 4.A: Reduce by two thirds, between 1990 and 2015, the under-five mortality rate			
Per cent reduction in under-five mortality rate, 990–2013	67	49 (substantial progress)	28 (no or limited progress)
Measles immunization coverage among 1-year-olds (%), 2013olds (%), 2013	90	84 (substantial progress)	66 (no or limited progress)
Target 5.A: Reduce by three quarters, between 1990 and 2015, the maternal mortality ratio			
Per cent reduction in maternal mortality ratio, 1990–2013	75	45 (substantial progress)	7 (no or limited progress)
Births attended by skilled health personnel (%), 2007–2014	90	74 (no or limited progress)	94 (met or on track)
Target 5.B: Achieve, by 2015, universal access to reproductive health1990 and 2015, the maternal mortality ratio			
Antenatal care coverage (%): at least one visit, 2007–2014	100	83 (substantial progress)	97 (met or on track)
Unmet need for family planning (%), 2012	0	12 (no or limited progress)	Data not available
Target 6.A: Have halted by 2015 and begun to reverse the spread of HIV/AIDS			
Per cent reduction in HIV incidence, 2001–2013	>0	46 (met or on track)	
Target 6.C: Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases			
Per cent reduction in incidence of malaria, 2000–2013	75	30 (no or limited progress)	not given
Per cent reduction in mortality rate of tuberculosis (among HIV-negative people) , 1990–2013	50	45 (substantial progress)	6 (no or limited progress)
Target 7.C: Halve, by 2015, the proportion of the population without sustainable access to safe drinking-water and basic sanitation			
Per cent reduction in proportion of population without access to improved drinking- water sources, 1990–2012	50	54 (met or on track)	74 (met or on track)
Per cent reduction in proportion of population without access to improved sanitation, 199 0–2012	50	32 (substantial progress)	38 (substantial progress)

Table 8.3 Provincial comparison of key demographic indicators *[Source: Msembure et al, 2014]*

Province	Infant Mortality Rate	Under 5 Mortality Rate	Adult mortality	Life expectancy
Eastern Cape	40,7	60,1	52,2	53,8
Free State	44,6	65,8	53,7	53,4
Gauteng	27,5	43,2	33,9	63,2
KwaZulu-Natal	44,3	66,0	52,8	52,9
Limpopo	25,9	41,6	37,7	63,6
Mpumalanga	40,5	60,0	47,4	56,6
North West	35,4	54,5	44,5	58,0
Northern Cape	33,0	45,3	43,9	59,3
Western Cape	16,5	24,9	26,6	68,0

■ Figure 8.4
Causes of death in South Africa (2013)



The primary cause of death in South Africa is TB followed by pneumonia and influenza (Figure 8.4).

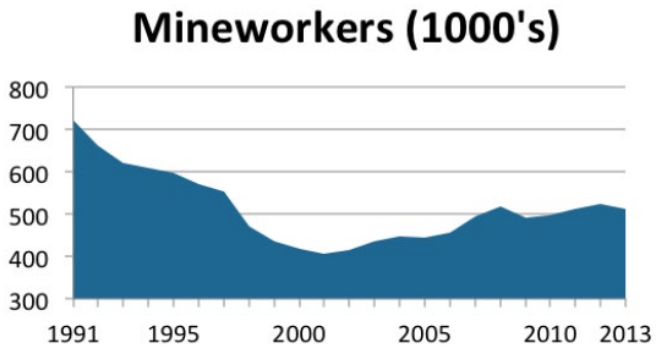
Mining landscape

South Africa is home to the deepest mines in the world. Mining takes place mainly in Gauteng, Free State, North West, Limpopo and Mpumalanga. Although little mining activity takes place in the remaining provinces, the Eastern Cape and Kwa-Zulu Natal provinces are typically labour-sending areas to the gold and platinum belts. South Africa is renowned for an abundance of mineral resources including: diamonds, gold, platinum and coal. Other minerals produced include chrome, manganese, vanadium, palladium, uranium and iron ore. South Africa's diamond industry is the fourth largest in the world following Botswana, Russia and Canada[3]. South Africa is the biggest producer of gold and platinum and one of the main producers of base metals and coal[3]. Gold and coal mining, in particular, are strongly associated with the development of silicosis (8-10 years after exposure) in miners. In some studies, up to 60% of miners develop silicosis in their lifetime[5]. This is evident, for example, in platinum miners who previously worked on gold mines and develop silicosis. Just under 500 000 miners are employed in the mines (Table 8.4) and (Figure 5). Except

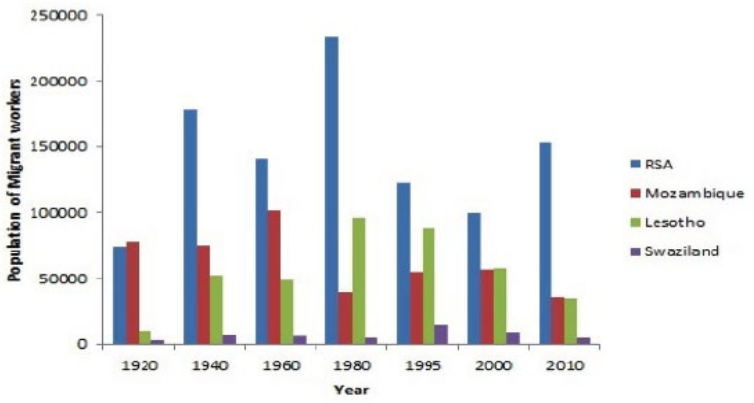
■ Table 8.4 Number of employed miners and industry of employment *[Source: xxxx]*

Year	Number employed	Chrome mining	Coal	Gold	Iron ore	Manganese	Platinum	Diamond	Aggregate and sand
2003	435620			198465					
2004	457371			187484					
2005	442911		56971	160634	7492		155030	21976	
2006	456000								
2007	485474		60439	169057	13858		186000	200000	
2008	518585	12279	65210	166421	13256	3934	199948	18609	
2009	491922	10893	72694	159925	13722	4988	184613	12046	
2010	498141	13971	73817	157019	18216	5879	181969	11143	
2011	513000								
2012	514760		83245	142193			197847		
2013	524632		87768	131591	21145	9866	191261	13547	7579
2014	496000			119000					
2015	462000								

■ Figure 8.5
Number of employed miners in South Africa (1991-2013)



■ Figure 8.6
Population of migrant workers employed in mining in South Africa by year



for Namibia and Botswana, South Africa's neighbouring countries send labour to the mining industry (Figure 8.6).

Artisanal and small-scale mining (ASM) is also becoming increasingly common. Most of these small-scale miners are unregulated and unlicensed in the gold regions. The number of undocumented miners is estimated to be around 14 000. These undocumented miners (local and migrant), are called "zama zamas", which can be loosely translated as "trying their luck". They work in disused mines or mine shafts across most of the gold rich areas, especially in Johannesburg[6]. However, formal tiger's eye artisanal mining does exist in the Northern Cape[7].

The problem with unregulated mining is that the workers are not provided with necessary health and safety services.

RESULTS

General Population TB and HIV Epidemiological Data

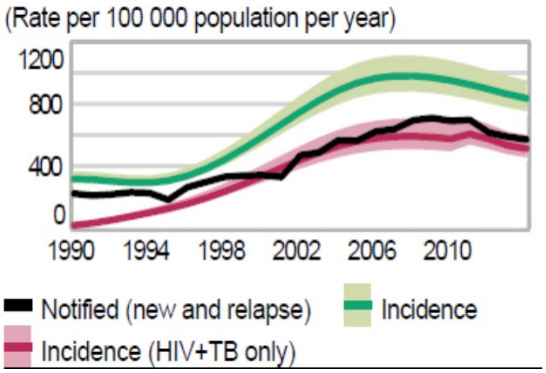
South Africa is one of the high TB burden countries, with rates of TB within the general population of 834 per 100 000, (Figure 8.7). The estimated multi-drug-resistant MDR-TB prevelence for new and retreatment cases was 1,8% and 6,7% respectively[8]. Of those with TB, 93% have a known HIV status. From these, 61% are co-infected with TB and HIV, with 79% on ART (Table 8.5)[8]. However, this is not consistent across provinces, and HIV coinfection

■ Table 8.5 **Reported TB/HIV South Africa (2014)**

	Number	(%)
TB patients with known HIV status	295 136	(93)
HIV-positive TB patients	179 756	(61)
HIV-positive TB patients on co-trimoxazole preventive theraphy	155 017	(86)
HIV-positive TB patients on antiretroviral theraphy (ART)	141 755	(79)
HIV-positive people screened for TB	1 148 477	
HIV-positive people provided with IPT	551 787	

■ Figure 8.7

TB incidence in South Africa from 1990 to 2010



■ Table 8.6 HIV/TB coinfections across provinces, South Africa (2015)

Province	Cohort	Known HIV status		HIV+		On CPT		On ART	
Eastern Cape	46 314	44 158	95,3%	20 922	45,20%	20 459	97,8%	20 026	95,7%
Free State	15 894	14 784	93,0%	9 545	60,1%	8 746	91,6%	8 062	84,5%
Gauteng	43 797	42 002	95,9%	29 969	68,4%	26 614	88,8%	25 455	84,9%
KwaZulu-Natal	73 272	69 015	94,2%	46 619	63,6%	42 033	90,2%	38 345	82,3%
Limpopo	17 012	16 235	95,4%	10 469	61,5%	9 140	87,3%	8 363	79,9%
Mpumalanga	17 024	15 936	93,6%	11 593	68,1%	10 492	90,5%	10 503	90,6%
North West	19 577	18 340	93,7%	11 819	60,4%	10 364	87,7%	9 733	82,4%
Northern Cape	7 630	7 110	93,2%	3 135	41,1%	2 933	93,6%	2 716	86,6%
Western Cape	42 565	40 904	96,10%	16 402	38,5%	13 300	81,1%	12 410	75,7%
South Africa	283 085	268 484	94,8%	160 473	56,7%	144 081	89,8%	135 613	84,5%

■ Table 8.7 Presumptive TB and identified patient data by province, South Africa (2015)

Province	Screened		People identified with TB symptoms		Tested		Tested +ve		Started treatment		Initial loss to follow-up		Died before treatment start		Total of outcomes
	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age			
Eastern Cape	6 738 485	43,5%	678 271	4,2%	560 439	82,6%	35 651	6,4%	33 199	93,1%	1 870	5,2%	565	1,6%	35 634
Free State	5 328 668	67,0%	182 614	2,3%	139 830	76,6%	11 686	8,4%	10 903	93,3%	597	5,1%	186	1,6%	11 686
Gauteng	4 805 543	27,1%	372 471	2,1%	313 882	84,3%	20 600	6,6%	18 673	90,6%	1 575	7,6%	218	1,1%	20 466
KwaZulu-Natal	5 898 490	24,4%	891 922	3,7%	747 529	83,8%	37 841	5,1%	37 551	99,2%	165	0,4%	123	0,3%	37 839
Limpopo	7 930 826	70,0%	267 763	2,4%	235 987	88,1%	8 012	3,4%	7 743	96,6%	168	2,1%	105	1,3%	8 016
Mpumalanga	969 240	12,3%	128 866	1,6%	117 295	91,0%	8 931	7,6%	8 399	94,0%	345	3,9%	110	1,2%	8 854
North West	1 738 743	23,3%	205 219	3,4%	168 553	67,4%	17 512	10,4%	13 024	74,4%	592	3,4%	359	2,1%	13 975
Northern Cape	1 036 040	42,1%	75 283	3,1%	74 340	98,7%	6 443	8,7%	5 935	92,1%	169	2,6%	74	1,1%	6 178
Western Cape	1 156 310	10,4%	183 052	1,6%	168 892	92,3%	21 911	13,0%	19 799	90,4%	1 773	8,1%	98	0,4%	21 670
South Africa	35 264 486	33,4%	3 030 461	2,9%	2 526 747	83,4%	198 587	6,7%	155 226	92,1%	7 254	4,3%	1 838	1,1%	164 318

is lower in the Western Cape (38,5%), Northern Cape (41,1%) and the Eastern Cape (45,2%) (Table 8.6).

In 2015, 6,7% (168 587/2 526 747) symptomatic individuals tested positive for TB. The highest cases were diagnosed in KwaZulu-Natal (37 841), Eastern Cape (35 651), and Western Cape (21 911) however, the highest proportion of TB cases among TB suspects was the Western Cape (13%), North West (10,4%) and Northern Cape (8,7%). Among those diagnosed with TB, 92,1% were started on treatment, while 4,3% were lost to follow-up and 1,1% died before treatment could be initiated (Table 9.7). More than 90% of patients were started on TB treatment in most of the provinces except in the North West where only 74,4% of patients diagnosed with TB were initiated on treatment.

The total number of TB drug resistance cases diagnosed in 2015 was 12 693 (Table 8). The highest number of cases was seen in KwaZulu-Natal (3 763) Eastern Cape (2 408) and Western Cape (1 750). North West and Free State, which are primary mining provinces, only reported 603 and 490 cases of drug resistant TB respectively, of which 0,8% and 2,4% were extensively drug resistant (XDR) TB respectively.

The national estimate for HIV prevalence among South Africans in 2012 was 19,2% and the antenatal prevalence for the same period was 29,5%[9]. The prevalence of HIV by province is shown in Figure 8.8. Around 31% of people living with HIV are on ART[10].

Summary of published secondary data

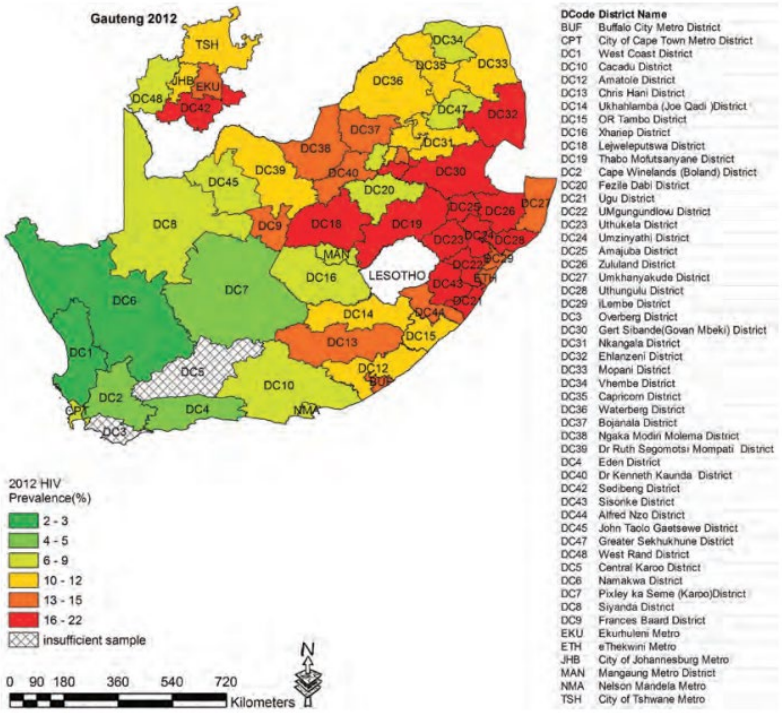
As part of the secondary data review, select research publications and reports for HIV/AIDS, TB and silicosis in South African miners have been summarised. In total, 53 research publications have been reviewed, covering the period 1991 to 2016. The reports cover six of South Africa's provinces, and exclude Limpopo, Northern Cape and Western Cape. The main commodities under review include: gold, platinum, coal and diamonds. A full table summarising all South Africa publications is in the Appendix 1.

Briefly, the data confirms the high TB prevalence in the mines, around 3 000 per 100 000 compared to around 900 per 100 000 for the general population. The TB rates have increased steadily with the plateauing of the HIV/AIDS epidemic. HIV co-infection increases risk of TB infection, TB recurrence, XDR-TB and death[14]. Even in the absence of HIV infection, silicosis increases the hazard of contracting TB by at least 3 times[15]. (Class action suits against gold mining companies to compensate miners who contracted TB and silicosis while working for these

■ **Figure 8.8**

Prevalence of HIV across districts in South Africa (2012)

[Source: SA National HIV Prevalence, Incidence and Behaviour Survey, 2012]



■ Table 8.8 Total Drug Resistance Cases
All Drug Resistant TB (irrespective of HIV status) by Province, South Africa (2015)

Province	Cohort (2015)	RR		MDR-TB		XDR-TB	
Eastern Cape	2 408	762	31,6%	1 341	55,7%	305	12,7%
Free State	490	350	71,4%	128	26,1%	12	2,4%
Gauteng	1 522	847	55,7%	621	40,8%	54	3,5%
KwaZulu-Natal	3 763	1 661	44,1%	1 944	51,7%	158	4,2%
Limpopo	490	357	72,9%	126	25,7%	7	1,4%
Mpumalanga	1 133	635	56,0%	450	39,7%	48	4,2%
North West	603	493	81,8%	105	17,4%	5	0,8%
Northern Cape	534	279	52,2%	230	43,1%	25	4,7%
Western Cape	1 750	583	33,3%	1 037	59,3%	130	7,4%
South Africa	**12 693**	**5 967**	47,0%	5 982	47,1%	744	5,9%

companies are ongoing[16]. The silicosis rate among miners is between 22% to 32% and up to 60% of miners will eventually develop silicosis in their lifetime[16].)

Miners TB and HIV Epidemiology

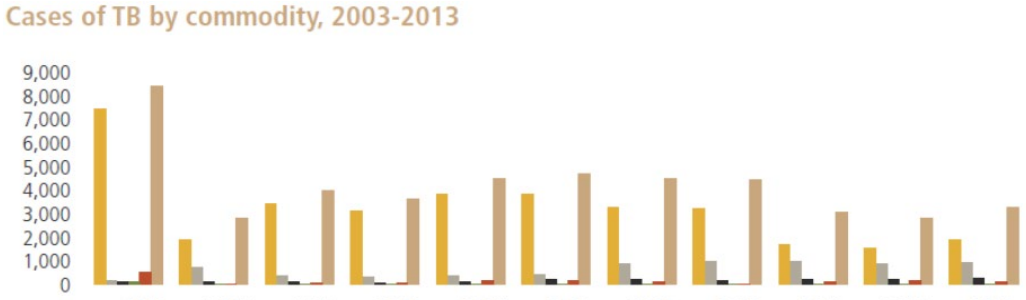
In addition to the high TB burden in country, South Africa is the epicentre of the TB epidemic in miners within Southern Africa. Reported TB incidence in miners is three times higher, about 3 000 per 100 000. However, this is probably underestimated as about half of the miners die with undiagnosed TB[17]. Across commodities, gold mining reports the highest number of TB cases (Figure 8.9). The TB epidemic among miners mirrors the HIV/AIDS epidemic in this population. The HIV prevalence rose from 1,3% in 1990 to 20%–30% by 1998[18]. The higher TB cases in miners are mainly fuelled by silicosis and HIV. Hence, efforts to control TB among miners should include silicosis prevention and HIV prevention and treatment programmes in mining communities. Likewise, rates of TB increased steadily, from 806/100 000 a year in 1991 to 1914/100 000 a year in 1998 and then to 3 821/100 000 per year in 2004[18]. Recent data shows that between 60 and 80% of miners with TB are co-infected with HIV, (Table 8.9). The benefits of the new test and treat strategy, irrespective of CD4+ count, that has been implemented from 1 September 2016 on rates of TB remain to be seen.

South African mines have workplace programmes for

■ Figure 8.9

Cases of TB by commodity in South Africa, 2003-2013

[Source: Tuberculosis in South Africa, fact sheet 2016, Chamber of Mines]



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Gold	7,461	1,926	3,442	3,115	3,846	3,829	3,266	3,243	1,696	1,529	1,900
Platinum	157	745	355	338	358	453	873	993	1,005	895	949
Coal	123	117	121	88	127	241	207	162	249	212	269
Diamond	139	11	30	12	9	8	4	8	6	8	6
Other	520	28	67	95	176	150	129	46	106	194	131
Total	8,400	2,827	4,015	3,648	4,516	4,681	4,479	4,452	3,062	2,838	3,255

■ **Table 8.9 Results of TB and HIV testing in 2013 and 2014**

Data elements	2 013	2014	2 015
Total labour force	**423 032**	**465 923**	**476 635**
Counselled for HIV	**229 151** (54.2%)	**259 297** (55.7%)	**299 566** (62,9%)
Tested for HIV	**192 557** (84%)	**183 202** (70.7%)	**191 333** (64,19%)
HIV Positive	**17 384** (9.0%)	**19 084** (10.4%)	**21 913** (11,39%)
Co-infected with TB and HIV	**2 905** (80.8%)	**2 820** (63.2%)	**3 063** (72,7%)
Living with HIV and on ART in 2014	**28 887**	**24 740**	**27 272**
Screened for TB	**308 403** (72.9%)	**376 718** (80.8%)	**422 670** (88,7%)
Diagnosed with TB	**3 593** (1.2%)	**4 461** (1.2%)	**2 211** (1.0%)
On TB treatment	**3 482** (96.9%)	**3 999** (89.6%)	**4 367**
Diagnosed with TB	**149** (4.1%)	**190** (4.3%)	**112** (2.7%)
On MDR-TB treatment	**172** (4.8%)	**197** (2.03%)	**131**
Diagnosed with extremely drug-resistant TB	**11** (0.3%)	**18** (0.4%)	**14**

TB and HIV. In 2014, 80,9% (376 718) of the workforce in large mines which are members of the Chamber of Mines was screened for TB. Of these, 4 461 (1,2%, or 1 184/100,000) were diagnosed with TB and 89,6% were started on treatment (Figure 8.10). MDR-TB and XDR-TB prevalence was 4,3% and 0,4% respectively (Table 8.9). The highest number of TB cases was recorded in the gold and platinum sector[19]. The HIV prevalence is about double (12,3%) in gold and platinum sector compared to coal and diamonds (6,7%), (Table 8.10). Over the years, TB and HIV co-infection reduced from 80,8% to 63,2% and screening for HIV among TB patients increased 72,9% to 80,8% (Table 8.10). About half of miners were counselled on HIV and 5,3% (24 740/465 923) of all HIV positive miners were on ARVs (Table 8.11).

The platinum sector, which employs most mine workers, has the best integrated HIV and TB policy and programme

■ **Figure 8.10**
TB/HIV coinfection all mines, South Africa (2014

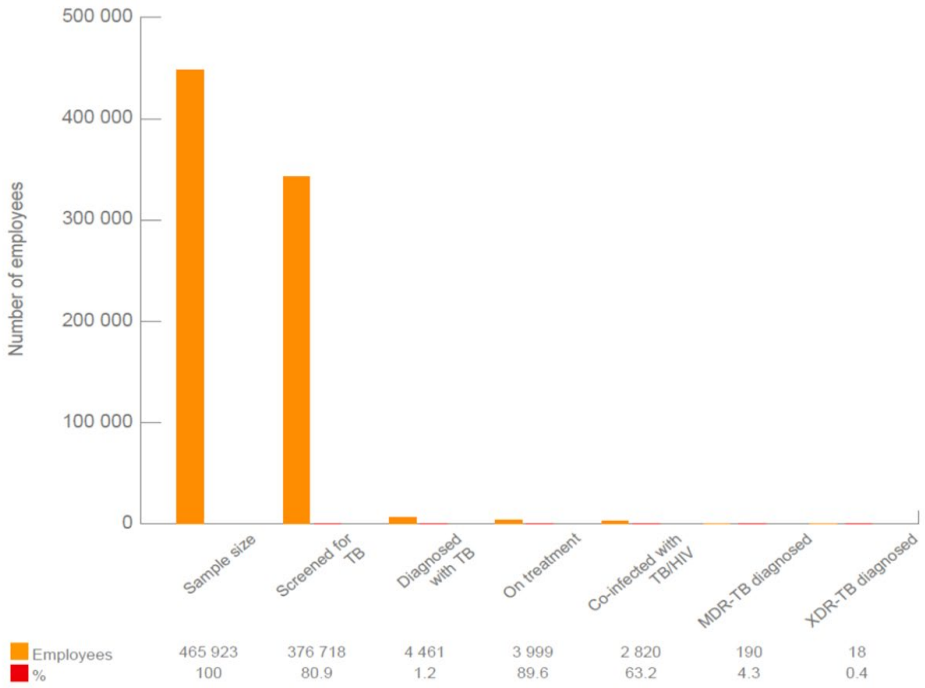


Table 8.10 HCT services and TB programme data elements per commodity

Data Elements	Coal Labour Force	Diamond Labour Force	Gold Labour Force	Platinum Labour Force	Other mines labour force	Total labour Force
Employees	93 924 (78)	9 227 (50)	113 161 (51)	160 490 (71)	89 121 (209)	465 923
Counselled for HIV	33 448 (35,6%)	1 898 (20,6%)	46 130 (48,8%)	144 786 (90,2%)	33 035 (34,5%)	259 297 (55,7%)
Tested for HIV	25 676 (76,8%)	684 (36%)	41 580 (90,1%)	94 296 (65,1%)	20 966 (63,5%)	183 202 (70,7%)
HIV Positive	1 727 (6,7%)	45 (6,6%)	4 518 (10,9%)	11 557 (12,3%)	1 237 (5,9%)	19 084 (10,4%)
Co-infected with TB and HIV	318 (83,9%)	29 (70,7%)	1 228 (67,2%)	941 (63,2%)	304 (45%)	2 820 (63,2%)
Living with HIV and on ART in 2014	5402	108	15 363	13 441	2 788	24 740
Screened for TB	73 133 (77,9%)	8 300 (90%)	79 614 (70,4%)	146 878 (80,3%)	68 793 (77,2%)	376 718 (80,8%)
Diagnosed with TB	379 (0,4%)	41 (0,5%)	2 218 (2,8%)	1 490 (1,0%)	333 (0,5%)	4 461 (1,2%)
On TB Treatment	362 (95,5%)	23 (56,1%)	2 088 (94,1%)	1 264 (84,8%)	262 (78,7%)	3 999 (89,6%)
Diagnosed with MDR-TB	20 (5,3%)	0	87 (3,9%)	53 (3,6%)	28 (8,4%)	190 (4,3%)
On MDR-TB treatment	14 (3,3%)	0	95 (4,2%)	74 (4,9%)	14 (0,5%)	197 (2,03%)
Diagnosed with XDR-TB	3 (0,8%)	0	5 (0,2%)	8 (0,54%)	2 (0,6%)	18 (0,4%)

Table 8.11 Data on HIV and TB Screening and Treatment in the mines (2013-2014)

Data elements	Total labour force: 2013 (423 032)	Total labour force: 2014 (465 923)
Counselled for HIV	229 151 (54.2%)	259 297 (55.7%)
Tested for HIV	192 557 (84%)	183 202 (70.7%)
HIV positive	17 384 (9.0%)	19 084 (10.4%)
Co-infected with TB and HIV	2 905 (80.8%)	2 820 (63.2%)
Living with HIV and on ART in 2014	28 887	24 740
Screened for TB	308 403 (72.9%)	376 718 (80.8%)
Diagnosed with TB	3 593 (1.2%)	4 461 (1.2%)
On TB treatment	3 483 (96.9%)	3 999 (89.6%)
Diagnosed with multi-drug-resistant TB (MDR-TB)	149 (4.1%)	190 (4.3%)
On MDR-TB treatment	172 (4.8%)	197 (2.03%)
Diagnosed with extremely drug-resistant TB (XDR-TB)	11 (0.3%)	18 (0.4%)

Table 8.12 Compliance for all mines per commodity (2014)

Measure	Coal mines: Mines: 78 Employees: 93 924	Diamond mines: Mines: 50 Employees: 9227	Gold mines: Mines: 51 Employees: 113 161	Platinum mines: Mines: 209 Employees: 89 121	Other mines: Mines: Mines: 209 Employees: 89 121	Total Mines: 459 Employees: 465 923
Integrated HIV and TB policy	65 (83.3%)	16 (32.0%)	20 (39.2%)	70 (98.6%)	136 (65.1%)	307 (66.9%)
Integrated HIV and TB programme	72 (92.3%)	14 (28.0%)	34 (66.7%)	68 (95.8%)	119 (56.9%)	260 (56.5%)
HIV and TB programme budget	60 (76.9%)	5 (10.0%)	31 (60.8%)	71 (100%)	78 (37.3%)	245 (53.3%)
Manage their own employees, including contractors	52 (66.7%)	13 (26.0%)	42 (82.3%)	40 (56.3%)	57 (27.3%)	204 (44.4%)

(Table 8.12) and the diamond sector, which employs the least miners has the lowest compliance with Chamber of Mines integrated HIV and TB policy.

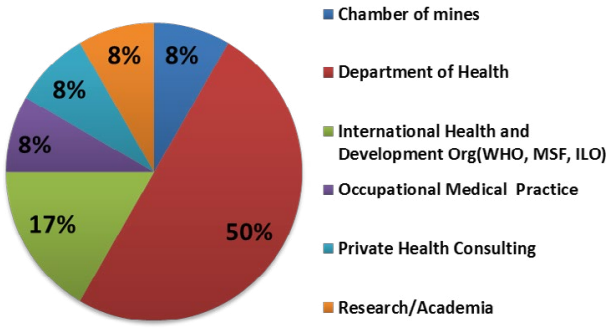
Perceptions of Key Informants

Population Description

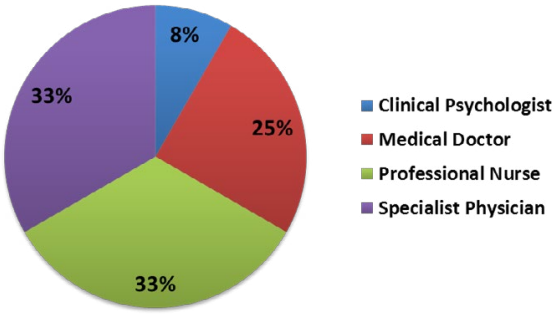
A total of 12 key informants were interviewed in South Africa for the TB in Miners project. The participants interviewed were based in Gauteng (6), North West Province (5) and Kwazulu-Natal Province (1). These informants represented various sectors, with half (6/12) of them working under the Department of Health. Most had been trained as health care workers (nurses, medical doctors) (Figure 8.11A and 8.11B) and had been in their current role for a median of 7 (IQR: 2-10) years. The median age of the informants was 52yaers (IQR: 51 – 57) years. The four informants that responded to the question, "Which mining industries are still active?" mentioned gold, platinum, diamonds, coal and magnesium. The big mining companies mentioned included AngloGold, Sibanye, Anglo American, Impala and Harmony mines. According to the informants, these big mining companies are in North West, Limpopo, Kwazulu-Natal, Northern Cape, Gauteng, Mpumalanga and Free State Provinces. The informants also opined that many of the mining companies (especially in the gold and platinum sectors) are scaling down operations. Most of the informants

■ Figure 8.11
Population Description

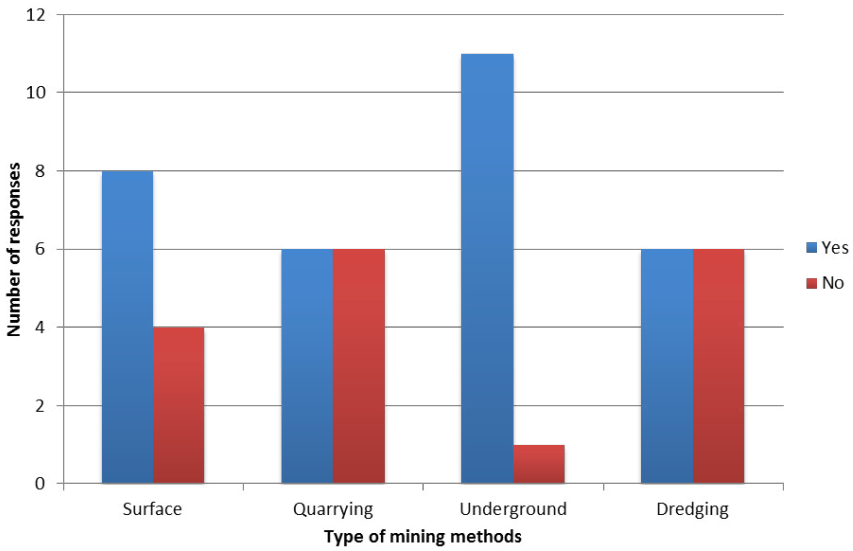
A: Sectors represented by the Key Informants



B: Occupation or Training of the Key Informants



■ Figure 8.12
Informants reponses about mining methods in South Africa



interviewed agreed that underground mining is still active, and only half knew about surface, quarrying and dredging mining methods (Figure 8.12).

Health Services for Current Mine workers

The health services provided to miners vary greatly between companies; the big companies generally offer most of the services, including HIV and TB screening and treatment. However, small to medium sized companies do not offer all the services and rely on health services provided by the government for the public.

"Big mines have all/most services, small to medium mines not all services"
(KI033, Occupational Medical Practice)

Based on the responses from the informants, current miners can access TB screening (10/12), TB prevention (9/12); and TB treatment (7/12) services. Five (5/12) informants also indicated that MDR-TB, HIV and silicosis screening, prevention and treatment are available in mines that offer occupational health services to miners. However, a couple of informants did indicate that contract mineworkers are excluded from accessing occupational health services at some of the mines. Miners receive limited paid sick leave if unfit to work due to illness. In some mines extended sick leave is granted for TB and MDR-TB. Sometimes, miners' benefits and bonuses are forfeited while on sick leave and in some companies, they can only claim for loss of income when they return to work. This results in miners concealing their illness and/or returning to work early.

Mine companies rarely do contact tracing for family members of an employee with TB. The current practice is that a TB patient is reported to the department of health and the expectation is that contact tracing would be done by the department.

Health Services for Communities

According to ten informants, most mining companies provide no health services for the dependents of mine workers or the peri-mining communities. Two informants commented that if a mining company provides services to other family members of the employee it would be through a medical aid fund. Anyone who is not an employee of the mine accesses health services at state facilities. One respondent also mentioned that mining companies are not legally obliged to provide health services for family members of their employees.

"If they are not working in the mines they have to go to the state facilities..."
(KI006, Department of Health).

Health Services for Ex-Miners

In some mines, miners are allowed to come back for general health reviews or follow-up for occupational diseases after they quit the mine, if they are diagnosed before they leave. However, even where mines offer health services many ex-miners do not use them, because they are not aware of them or cannot afford to come back to the mine area.

"Mine policy is they can come back to employer for physical exam every two years, but most never come back because of travel costs. Any services are accessed in local clinics where they are."
(KI033, Occupational Medical Practice).

Relatively new occupational health services have been established in Gauteng and Eastern Cape for ex-miners to obtain occupational disease screening and diagnosis and referral for compensation if necessary. There are also plans to establish another occupational health centre for miners in Limpopo with European funding. Most ex-miners access health services at state facilities for free.

"The state has a legal obligation to provide screening and compensation services for ex-miners"
(KI012, Research/Academia).

Health System

The occupational health services provided to ex-miners are inadequate, despite the legislation.

"I cannot comment on the services provided by the mining companies. However, the services provided by the South African government for ex-miners, despite a legal obligation, is weak, almost non-existent, and where it does exist is staffed with inappropriately trained medical staff."
(KI012, Research/Academia).

One key informant indicated that the services were previously adequate, but with many mines scaling down, especially the gold mines, health services are no longer sufficient.

Health and Safety Legislation

All 12 key informants agreed that the South African government has legislation on mine health and safety. Most of the informants also highlighted that the legislation specifies how health issues and injuries should be dealt with and reported to the relevant authorities.

"All occupational disease or issues should be reported, whether it is trauma, TB, injuries, heat strokes etc they get sent to the ministry of mining. The unions can be aware of such reports. The issue revolves around the matter of that if the miners are within they are likely to be reported, if in the public sector than they are not reported.

(KI007, Department of Health).

The legislation is updated and regulated by the Departments of Labour, Mineral Resources, Chamber of Mines and Labour Unions. Some of the sections need to be reviewed and updated especially "ODEMO". According to the informants, the health and safety representatives at mines monitor adherence to policies, reporting of injuries and educating other employees; however, there are not enough health and safety representatives, with a ratio of 1:50/100 employees.

TB and MDR TB prevalence

In total, 83% (10/12) of informants responded to the question of the TB prevalence in mine workers and they all said that TB prevalence is higher in miners compared to the general population.

"TB is still high in mining industry; that industry is the hub of TB"

(KI003, Private Occupational Consultant)

"TB mine workers are at risk because of silica dust. If one person has TB and they are all are at risk of catching TB."

(KI006, Department of health).

The informants further commented that ex-miners are also at high risk of TB and may not have access to TB treatment because they no longer have an income and cannot access mine occupational health services. Ex-miners would then seek care in government facilities where their previous occupational history is not usually checked and occupational health services are not available.

"They are forgotten communities, they are a neglected group"

(KI007, Department of Health)

According to the informants TB is also high among the peri-mining communities, and this could be exacerbated by living conditions in informal settlements and close contact with mineworkers. In general, informants indicated that about 70%-80% of miners with TB are co-infected with HIV. There was no consensus on the prevalence of MDR-TB among miners; half of the informants (4/8) said it is lower or similar to the general population levels and the other half responded that MDR-TB in miners is higher than in the general population.

"Large proportion of MDR-TB, most miners don't disclose it due to fear of victimisation/ stigma attached to it."

(KI003, Private Health Consultant)

HIV Prevalence

There were six informants that responded to the question of HIV prevalence in current miners, ex-miners and their communities. Based on their reflections, HIV prevalence is higher among miners, ex-miners and their communities. Some of the stated risk factors included high rates of risky sexual behaviour (multiple partners, sex workers), separation of employed miners from their families, migration and economic activities around the mines. A few informants indicated that they would not say HIV prevalence is higher in miners and their communities because some regions (Kwa-Zulu Natal) that are not necessarily mining areas are known to have the highest HIV prevalence in South Africa.

"The prevalence is high, most miners stay away from their families, some of them have multiple partners."

(KI011, Department of Health).

Silicosis Prevalence

"It has a long latent period, see it after 8-10 years of exposure, most of the affected miners are still fit to work, highest rate in the world"

(KI003, Private Health Consultant).

The informants interviewed commented that silicosis is very high among mine workers, especially gold mine workers, compared to platinum. Silica exposure prevention has averted an increase, especially in big mines. However, compliance with wearing protective gear is still a problem. The bigger problem is that silicosis develops after the miners have stopped working and are unable to access occupational health services. Thus, silicosis is under-diagnosed in ex-miners.

"There is an extremely high prevalence with an alarming high percentage of undiagnosed disease."

(KI012, Research/Academia).

Summary of key findings

The available data as detailed in this chapter points to a TB epidemic in South Africa, mainly driven by the HIV epidemic in the general population. The risk of miners contracting TB is increased by the presence of silicosis regardless of HIV-status. While, silicosis is predominantly a problem in the gold mining industry, there is significant movement within the industry and workers previously employed in gold mines, for example, can move to the platinum sector. Miners employed in commodities not associated with a risk of developing silicosis may still develop silicosis because of prior exposure.

From the key informant interviews, it appears that only current miners and not their families can access mine health services – when these are available. Occupational health services are available only for miners employed in the big mines while those working for smaller mines access health through public health facilities. For most miners, employment benefits largely cease when they get sick. There is minimal sick leave and so mine workers are unwilling to be treated for TB. Also, workers with undiagnosed disease at the time of exit from employment are unable to access mine occupational health service should they develop symptoms after leaving the mine. This is particularly important because labour-sending areas, including Lesotho, Swaziland and Mozambique, have little to offer in terms of occupational health services for ex-miners.

Artisanal and small-scale miners present a different challenge in terms of accessing health-care services as their operations are largely illegal. No studies have been done among this population to describe the size of the population and their communities as well as their need for occupational health services.

Gaps and limitations

- There is a data gap on artisanal and illegal miners and their surrounding populations. Further studies are needed to describe these populations and quantify their disease burden and risk.
- South Africa recently adopted the test-and-treat strategy for HIV. The impact of this strategy on TB, including among miners, is yet to described.
- Studies that characterise progression of silicosis will help design strategies for miners, based on years of employment/exit from mining activities.

Conclusion

HIV and silicosis contribute to higher rates of TB among miners in South Africa. The effective control of TB in this population requires a multi-sectoral approach between the Department of Health and Department of Mineral Resources. Also, trans-border health services should be provided to cater for migrants that return home when unwell. A remaining challenge will be providing some occupational health services and HIV care to illegal miners within the current legal framework.

Recommendations

To effectively combat TB in South Africa, we recommend:

- Active case finding of TB in miners
- Wide implementation of IPT prophylaxis
- Tracking of patients to their home provinces or countries
- Regulation and documentation of artisanal and small-scale mining
- Studies among artisanal/illegal miners to describe the epidemiology of TB/HIV in this population
- An increased focus on health versus safety in mining
- Implementation of the known strategies to prevent exposure to silica dust
- Ongoing education on the importance of regular medical check-ups for miners
- Ongoing education of, and awareness-raising for, miners, their family members and healthcare workers about the importance of autopsies for miners
- Regular review and analysis of the autopsy database for miners and ex-miners
- Strengthening occupational health services in mining and labour- sending districts, and
- More research on TB prevention in miners.

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For many decades, Southern Swaziland has served as a labour-sending area for the gold mines in South Africa. Many more miners (10 000 to 15 000) are employed on South African mines than in Swaziland.

Chapter 9: **Swaziland**

Executive summary

Background: Swaziland is a small, landlocked country in southern Africa, divided into four districts with a population of 1,3 million. The unemployment rate is 22% with 63% of the population living below the poverty line. HIV and TB continue to be major public health problems and are the main causes of death in the country.

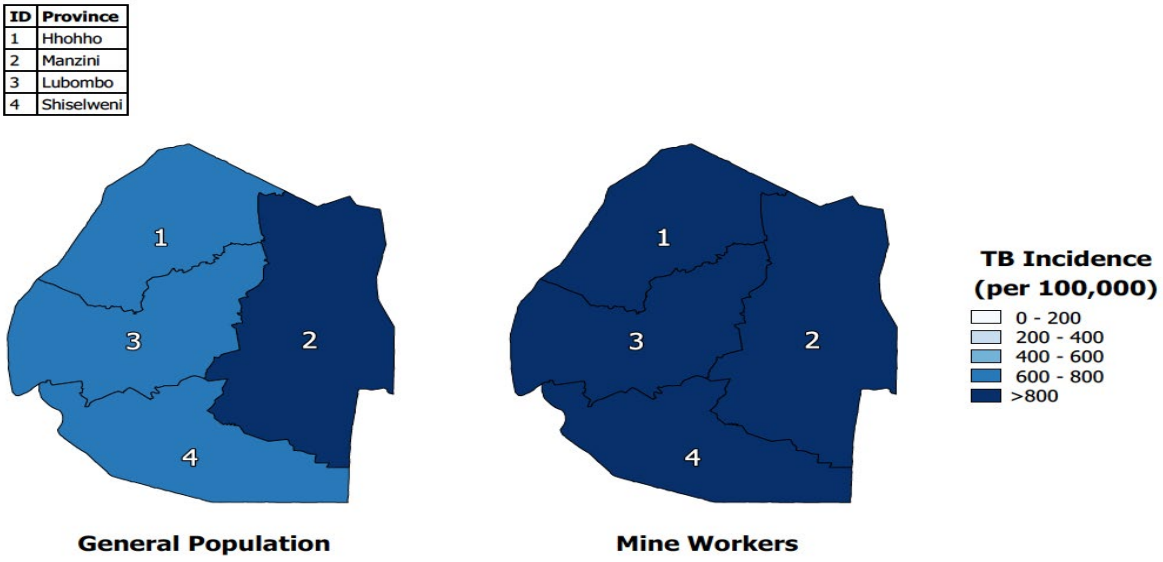
Key findings: The country has the highest TB incidence rate in the world (733/100 000) and HIV prevalence of 29% with 11 000 new HIV infections reported in 2015. HIV prevalence amongst pregnant women is 37%. Mining in Swaziland has a long history and mining's contribution to GDP is 2% with the most profitable commodities being iron ore, coal and diamonds. Importantly, Swaziland is a labour-sending area for South African mining companies, with most miners coming from the Southern region. Available data shows that the prevalence of TB and HIV in miners is higher than in the general population. Similarly, the TB and HIV incidence is highest in labour sending areas of Lubombo, Hhohho and Shiselweni.

Limitations: Documentation of ex-miners is poor and there is no data on silicosis in miners in Swaziland.

Recommendations: OHS in Swaziland should be supported by a functional referral system from South African companies. Additionally, a database of current and ex-miners should be developed and regularly maintained.

■ Figure 9.1

TB incidence in general population and estimated TB incidence in mine workers in Swaziland



Introduction

Swaziland, formally known as the Kingdom of Swaziland, is one of the smallest, landlocked, sovereign states in Southern Africa (in terms of land area and population size) and is bordered by South Africa on the west, north and south and Mozambique on the east (Figure 921). Swaziland is divided into four administrative regions which are also health districts (Hhohho, Manzini, Lubombo, Shiselweni) and has two capitals, Lobamba, the legislative capital, and Mbabane, the administrative capital[1]. The country population size for 2016 is projected at 1 304 063[2] with an almost equal split between males and females. Of the four regions, Manzini has the largest population size (Table 9.1). The primary languages are Swati and English.

■ **Figure 9.2**
Map of Swaziland

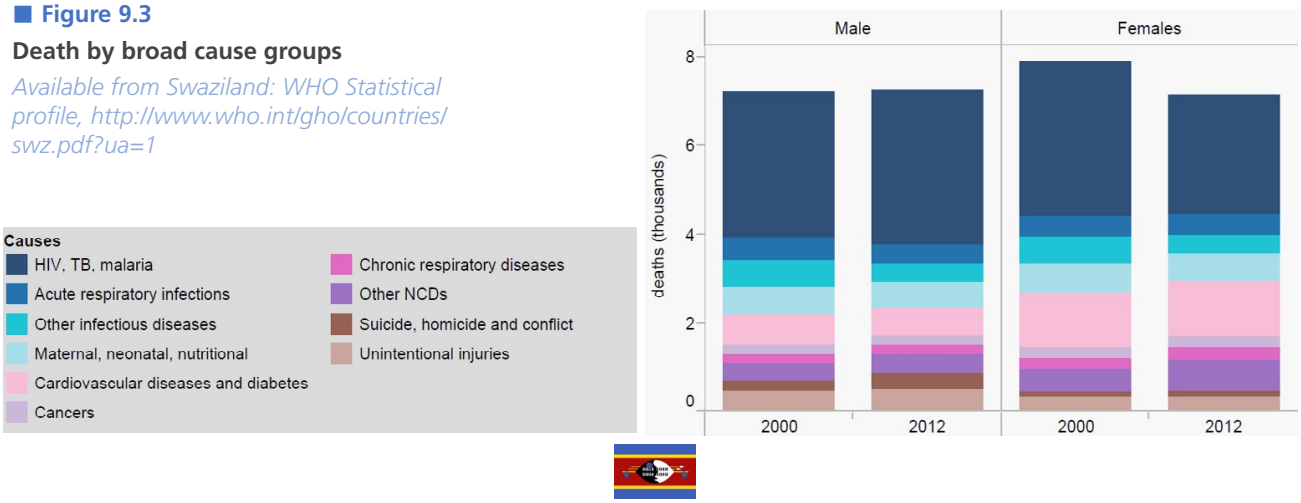
■ **Table 9.1 Population size by region** *Available from Mapping study*

Hhohho	**28 2734**
Manzini	**31 9530**
Lubombo	**20 7731**
Shiselweni	**20 8454**

General health indicators

The country's total expenditure on health is 9,3% of GDP with an estimated life expectancy for females and males of 48,5/49,7 years[2]. The country reports an overall crude birth rate of 37,3/1 000 and overall crude mortality rate of 14,8/1 000[3]. The rate of infant deaths under one and five years is reported as 57,9 deaths/1 000 live births and 80,6/1 000 respectively[2]. The main causes of death for children under five years are acute respiratory conditions, HIV and prematurity[3]. The maternal mortality ratio is 310/100 0007[4]. HIV, TB and Malaria are the main causes of death for both males and females in Swaziland (Figure 9.3)[3] Swaziland has both a formal and informal health-care system with the informal health care system consisting of traditional healers[4]. In the formal sector, services are provided by both public institutions and private entities such as NGOs and missionaries[5]. Swaziland has nine hospitals, 229 clinics and seven health centres (Table 9.2)[6]. The country reports a total of 241 doctors/physicians were working in the country in 2010, with the patient-to-doctor ratio sitting at 23:1[5]. Nurses form most of the overall health sector human resources and 1 911 nurses were recorded as active in 2010[5].

■ **Figure 9.3**
Death by broad cause groups
Available from Swaziland: WHO Statistical profile, http://www.who.int/gho/countries/swz.pdf?ua=1



■ **Table 9.2 Number and type of health facilities in Swaziland by region** *Available frommapping Study*

District	Total	Clinic	Health Centre	Hospital	Laboratory
Hhohho	67	62	2	2	1
Lubombo	99	92	2	4	1
Manzini	34	31	2	1	
Shiselweni	**47**	**44**	**1**	**2**	

Mining landscape

Mining in Swaziland has a long history, though in recent times has not played a dominant role in Swaziland's economy. Mining's contribution to GDP is estimated at 2%[7] Swaziland's principal economically beneficial mineral commodities include iron ore, coal (anthracite), aggregate (crushed rock) and diamonds. Other commodities include tin, nickel and manganese, but these are not commonly mined due to high costs. The Maloma colliery in the Lubombo region is Swaziland's only official mine, with 75% of the mine owned and operated by South African Xstrata and 25% owned by the Swazi government[7]. Around 2 520 Swazis are formally employed in the minerals sector. Of these 118 are contract miners, 368 are ex-miners and 2 034 are current miners[3]. There are also 7 398 beneficiaries (Table 9.4)[6]. For many decades, Southern Swaziland has served as a labour-sending area for the gold mines in South Africa (Table 9.3)[8]. Many more miners (10 000 to 15 000) are employed on South African mines than in Swaziland. Swaziland's mining industry and resource development and production faces numerous challenges, including: a low level of exploration and development, the high level of HIV infections, and a lack of infrastructure (both in mining and health services)[9].

■ **Table 9.3 Mine migration to South Africa, Mozambique and Swaziland (1920-2005)**
Available from http://www.queensu.ca/samp/sampresources/samppublications/policyseries/Acrobat53.pdf

Year	Mozambique	Swaziland
1920	77 921	3 449
1925	73 210	3 999
1930	77 828	4 345
1935	62 576	6 865
1940	74 693	7 152
1945	78 588	5 688
1950	86 246	6 619
1955	99 449	6 682
1960	101 733	6 623
1965	89 191	5 580
1970	93 203	6 269
1975	97 216	8 391
1980	39 539	8 090
1985	50 126	12 365
1990	43 951	16 618
1995	53 321	14 611
2000	44 245	8 079
2005	46 256	6 878

■ **Table 9.4 Mine population and beneficiaries in Swaziland by region** *Available from Mapping studies*

Province	Population size	Size of mining population	Distribution of mineworkers (%)	Proportion of mineworkers in relation to total population (%)	Number of beneficiaries
Hhohho	28 2734	403	15,9%	0,14%	1407
Manzini	31 9530	540	21,4%	0,17%	1910
Lubombo	20 7731	1030	40,8%	0,50%	1859
Shiselweni	20 8454	547	21,7%	0,26%	2222
Total	**1 018 449**	**2520**	**100%**	**1,07%**	**7398**

Results

TB and HIV Epidemiology

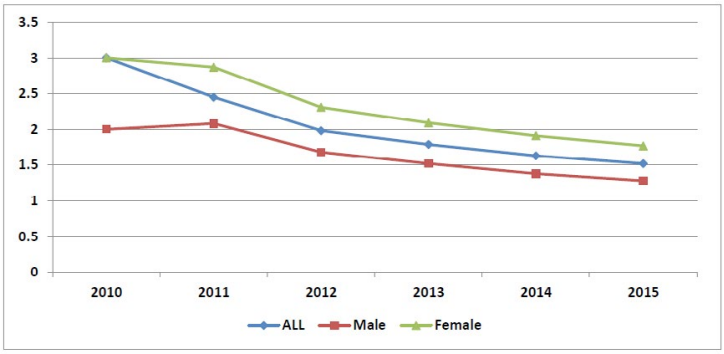
HIV and TB has had a devastating effect on Swaziland. In 2015, a total of 220 000 [200 000-240 000] people were living with HIV and the overall prevalence was 28,8%[10]. In the same year 11 000 new HIV infections were recorded and there were 3 800 AIDS related deaths[10]. Although the HIV incidence (Figure 9.4) and transmission frommother to child has decreased they are still relatively high. Women are disproportionally affected by HIV, especially the 15-35 age range (Figure 9.5), with approximately 31% of all women living with HIV compared to 20% of all men[11]. The antenatal HIV prevalence in Swaziland is about 37%[12].

HIV testing has increased in Swaziland. An estimated 40% of the population were tested in 2011, and 49% of HIV positive adults and 46% of HIV positive children were put on ART[11], while 73% of people in a high-risk sexual context reported that they use condoms[12]. It was reported that by December 2013, 100 138 of the 122 185 people in need of treatment (82%) were receiving ART, and 9 522 of the 11 307 HIV positive pregnant women (84%) were receiving PMTCT services[12]. Furthermore, the ARV retention rate in the first six months in Swaziland has improved from 83% in 2007 to 92% in 2012[12]. The proportion of TB patients testing for HIV infection has increased from 86% in 2010 to 96% in 2013 (Figure 9.6)[13].

■ **Figure 9.4**

HIV Incidence by sex among 15-49 year olds (2010-2015).

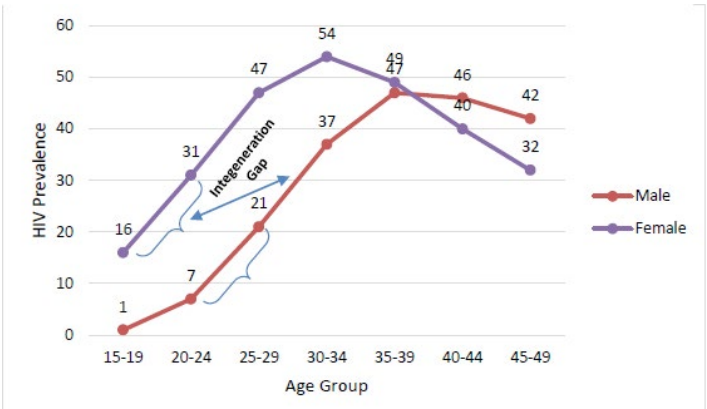
Available from Swaziland Global AIDS Response Progress Reporting (Spectrum HIV Estimates and Projections 2013, unpublished)



■ **Figure 9.5**

HIV Prevalence by sex among different age categories.

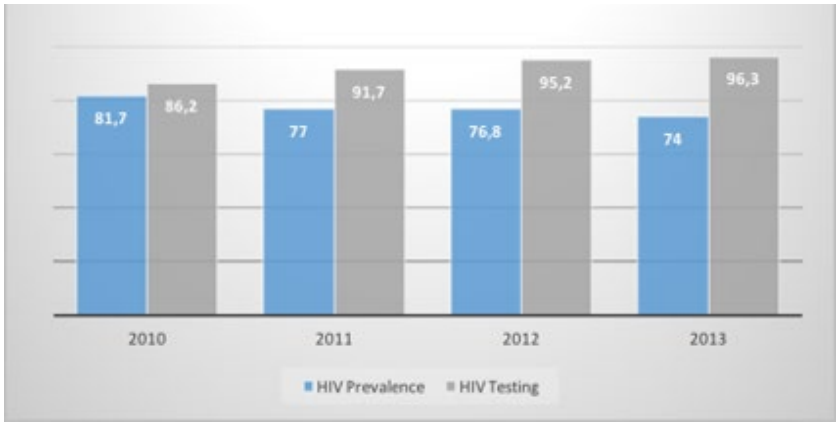
Available from Swaziland Global AIDS Response Progress Reporting



■ **Figure 9.6**

Trends of HIV testing uptake among TB cases 2010-2013

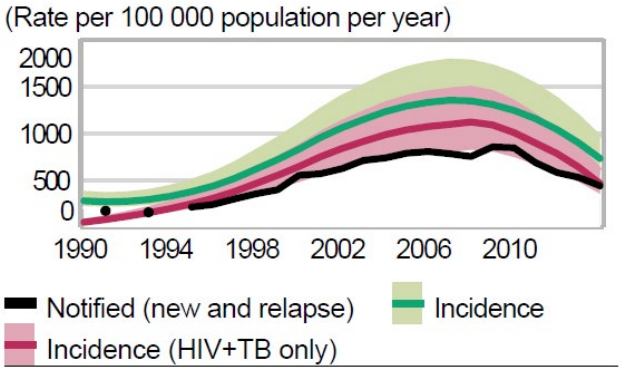
Available from Swaziland Ministry of Health NTCP 2014



■ **Figure 9.7**

Profile of TB in Swaziland over the years

Available from WHO Swaziland 2014 Tuberculosis profile.



The incidence of TB in Swaziland has decreased over the years (Figure 9.7) but the country still has one of the highest TB incidence rates in the world, 733/100 000[13] In 2014, there were an estimated 5 583 new and relapse cases of TB, with slightly more cases reported in men over the age of 15 years compared to women[13] In 2014, of those tested, 73% of HIV-positive patients had TB, and from this cohort 79% were on ART (Table 9.5)[13]. The HIV/TB mortality rate for Swaziland is estimated to be 135/100 000[15]. It is estimated that 7,7% (Table 9.6) of new TB cases and 34% of retreatment cases in Swaziland have MDR-TB[14]. The number of confirmed cases of MDR-TB has increased from 144 in 2007 to 403 in 2013 (Table 9.7)[13]. Treatment initiation for MDR TB cases has varied over the years with 65% of confirmed cases treated in 2008, 54% in 2011 and 107% in 2014[13].

■ **Table 9.5 Reported TB/HIV Swaziland 2014. Available from WHO Swaziland 2014 Tuberculosis profile**

TB/HIV 2014	Number	(%)
TB patients with known HIV Status	5 430	(97)
HIV-positive TB patients	3 972	(73)
HIV-positive TB patients on co-trimoxazole preventive therapy (CPT)	3 904	(98)
HIV-positive TB patients on antiretroviral theraphy (ART)	3 123	(79)
HIV-positive people screened for TB	110 370	
HIV-positive people provided with IPT	1188	

■ **Table 9.6 Reported MDR TB Swaziland 2014. Available from WHO Swaziland 2014 Tuberculosis profile**

Estimates of MDR-TB burdern 2014	New	Retreatment
% of TB cases with MDR-TB	7.7 (4.8-11)	34(28-39)
MDR-TB cases among notified pulmonary TB cases	320(200-440)	120(100-140)

■ **Table 9.7 Trends of MDR-TB cases identified and started on treatment: 2006 – 2013**

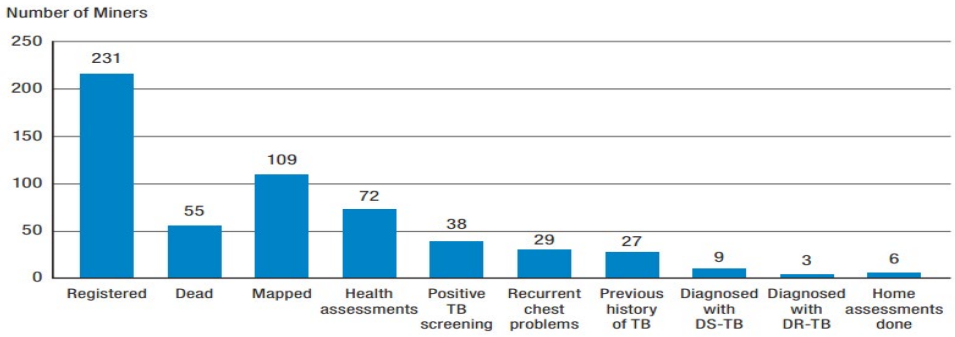
Available from Swaziland Ministry of Health NTCP 2014

Year	Confirmed MDR-TB Cases	Confirmed Cases initiated on treatment	Proportion
2006	0	12	0
2007	144	23	16%
2008	183	119	65%
2009	206	169	82%
2010	242	297	81%
2011	279	152	54%
2012	196	152	78%
2013	403	430	107%

■ **Figure 9.8**

Mapping of mineworkers, Nkwene community, Shiselweni Region (March-April, 2014)

Available from USAID Mapping mine workers in Nkwene, Swaziland to improve access to TB diagnosis and treatment services



Published literature

Two separate mapping studies were conducted in 2014. The first mapping study undertaken from March-April 2014, by USAID in collaboration with the Swaziland Miners Association and the National Tuberculosis Control Program (NTCP) focused on current and ex-miners within the Nkwene community in the Shiselweni Region of Swaziland[16]. The goal of the mapping study was to assess the health status of the community's current and former miners, including their need for TB diagnosis and treatment[16] During the study time frame, 231 miners were registered, ranging in age from 35-70 years, with 1-31 years of mining experience. Of all those registered, only 49% were mapped for the study (Figure 9.8). Study results found 5% (12/231) of the registered miners had TB and 25% of those (3/12) had MDR-TB (Figure 9.5). The study findings indicate that the prevalence of TB in miners is higher than the general population and needs to be urgently addressed.

The second mapping study was funded by the World Bank, starting in December 2014, and mapped mineworkers and ex-mineworkers across four Southern African countries (South Africa, Mozambique, Swaziland and Lesotho). The main objective of the study was to generate accurate, detailed, and up-to-date information on the demographic characteristics of current and ex-mineworkers and the availability of TB screening and treatment facilities[6]. The findings from this mapping study reiterate that Swaziland is a labour-sending area for South African mining companies with most miners coming from the Lubombo region[6].

In 2012, Corno and de Walque published a paper examining whether participation in mining in a bordering country affects HIV infection rate in Swaziland and Lesotho[17]. Using the Swaziland country-specific Standard Demographic and Health Surveys (DHS) conducted 2006-2007 looking at miners and their partners, the overall findings indicate that migrant miners (20%) and their partners (43%) are more likely to be HIV infected (Table 9.7)[17]. Wives and partners of men working in the mining sector would also benefit from being the focus of HIV prevention interventions.

In 2010, Crush et al. published a report exploring migration-induced HIV in Mozambique and Swaziland to examine the vulnerability to HIV and AIDS of the rural partners of migrant miners[8]. The study found that

a quarter of the respondents identified HIV and 19% identified TB as the causes of death of miners and ex-miners[8]. HIV is also perceived as the leading cause of death of community members. Miners perceived themselves at low risk of HIV compared to their partners (Figure 9.9) despite indication of risky sexual behaviours. The study concluded that mobility and vulnerability are connected.

■ **Table 9.8**

Mines, migration and HIV/AIDS in Southern Africa

Available from http://www.queensu.ca/samp/sampresources/samppublications/policyseries/Acrobat53.pdf

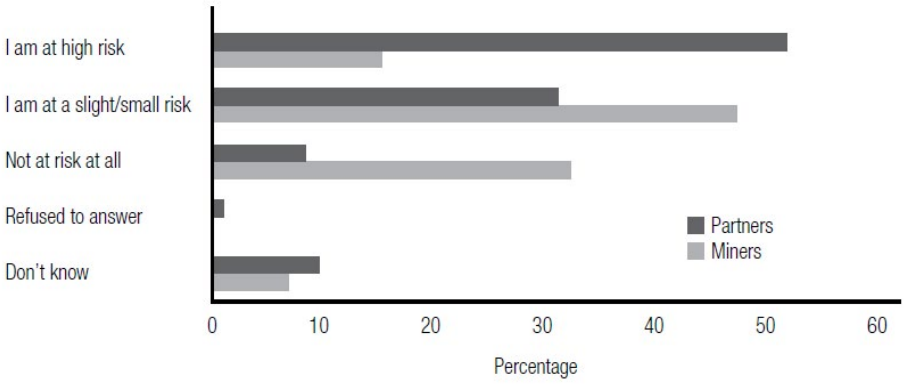
	Pooled Sample				Lesotho (2004)				Swaziland (2006-07)				Zimbabwe (2005-06)			
	Men		*Women*		*Men*		*Women*		*Men*		*Women*		*Men*		*Women*	
	Respondent's job	*HIV +*	*Partner's job*	*HIV +*	*Respondent's job*	*HIV +*	*Partner's job*	*HIV +*	*Respondent's job*	*HIV+*	*Partner's job*	*HIV +*	*Respondent's job*	*HIV+*	*Partner's job*	*HIV +*
Miners/quarrymen	3.97	21.7	14.89	35.0	3.18	40.0	31.58	36.0	2.82	20.0	6.53	43.3	4.95	18.0	5.78	30.0
Clerical	1.61	25.1	2.52	25.7	1.54	30.0	1.71	29.0	2.00	34.3	3.67	29.1	1.41	14.4	2.67	23.2
Other skilled manual	14.19	27.1	21.8	33.4	11.01	31.9	17.50	37.4	17.7	33.6	30.7	38.1	13.41	19.6	21.26	29.4
Services	6.78	23.5	8.37	30.5	3.25	27.4	4.50	34.4	10,49	23.1	11.76	38.1	6.01	23.2	9.94	25.5
Agriculture employees	4.71	18.8	4.62	24.9	9.3	13.5	6.50	16.2	4.29	28.3	5.23	33.0	3.16	16.8	3.01	26.7
Professional/managerial	5.90	20.2	9.17	28.2	2.82	24.0	3.63	27.5	7.74	23.2	15.0	25.6	6.03	16.7	11.0	29.7
Unskilled manual	1.10	20.4	1.92	32.8	3.47	21.2	4.01	34.4	---	----	----	----	0.81	19.1	1.12	30.7
Household and domestic	3.02	15.3	2.66	29.4	--	--	0.42	18.1	---	----	--	--	5.85	14.8	4.52	29.8
Agriculture self-employed	15.45	16.0	17.72	20.3	10.05	20.1	18.53	22.9	7.02	26.2	5.47	38.5	22.44	13.6	21.26	17.7
Salesmen, shop assistants	4.11	21.8	6.08	32.0	2.47	32.0	3.80	38.0	5.43	25.2	7.10	50.3	3.99	16.5	7.36	23.7
Unemployed	38.55	10.2	5.15	31.7	52.66	13.6	7.35	28.0	42.51	9.5	14.41	33.4	30.76	8.0	0	0
Don't know/Don't answer	0.60	29.0	5.09	8.0	---	---	---	---	---	---	---	---	1.19	29.0	10.7	23.8

Notes: The pooled sample includes Lesotho, Swaziland and Zimbabwe. Table reports the fraction of respondents in each occupation, for jobs with more than 10 observations each. Source: Author's analysis based on data from Demographic and Health Surveys (Lesotho Government and ORC Macro, 2005; Swaziland Government and ORC Macro 2008; Zimbabwe Government and ORC Macro, 2007).

■ **Figure 9.9**

Self-assessment of perception of risk to HIV infection

Available from Migration-induced HIV and AIDS in rural Mozambique and Swaziland



■ Table 9.9 Summary of Swaziland Published literature on mining and health

YEAR	METHODOLOGY	RESULTS	COMMENTS
2015 **USAIDS Report**	Cross-sectional Survey with current and ex-mine workers from the Shiselweni Region	TB: 12/231 (5%) (5194 per 100000); MDR-TB: 3/12(25%)	The TB burden in miners/ex-miners is higher compared to the general population (900/100000). The high burden of lung disease and TB among ex-mine workers is a challenge for health service delivery in mining communities that needs to be urgently addressed.
2014 **University Research South Africa**	Obtain and consolidate information and map it into GIS location maps		The findings from this mapping study reiterate that Swaziland is a labour sending area for South African mining companies with the majority of miners coming from Lubombo region
2012 **World Bank Development Research Group**	Country specific - Standard Demographic and Health Surveys looking at miners and their partners	HIV Prevalence: 20.0% (men) and 43.3% (women whose partners are employed in mining)	Women who have a husband or a cohabiting partner employed in the mining sector are also more likely to be tested HIV positive. Wives and partners of men working in the mining sector would also benefit from being the focus of HIV prevention interventions.
2010 **Crush et al.**	Questionnaires with current miners		This study has confirmed that mobility and vulnerability are intimately connected. It has also suggested that the causes and consequences of vulnerability of migrants and their partners are closely connected.

Perceptions of key Informants

Descriptive data

A total of 15 key informants were interviewed in Swaziland for the purpose of the BeST In Miners study project. Majority (9) of the participants resided at Hhohho region, five were from Manzini and only one wasfrom Shiselweni region. The median age of the participants was 42 (IQR 27: 50 years old). The key informants represented different sectors as follows: Department of health (6), International health and developmental organisations (5), Research/Academia (2), Labour Department (1) and Labour Union (1). The informants had varied educational background with most trained as health care professionals, occupying distinctive roles from their respective sectors such as: TB programme managers, labour principal investigator, medical doctors, researchers etc... (Figure 9.10)

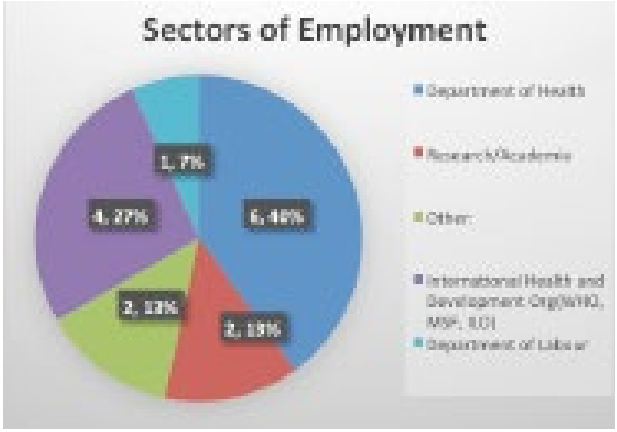
Mining

Quarrying was the most common known type of mining activity in Swaziland according to the key informants, followed by underground and surface mining. Based on the responses we received, most commonly known commodities mined is coal and iron ore (Figure 9.11). Few informants mentioned asbestos, gold and diamond to be some of the commodities that were previously mined in Swaziland. These informants also mentioned that such commodities are no longer actively mined in Swaziland. Based on the collected information, Maloma coal mine in Lombobo region is known as the largest employer in the mining sector. The other mines cited by the informants included Mpaka and Lufafa mine in Hhohho; and Pigs Peak and Ngwenya mines. Although Ngwenya used to be the biggest employer, currently it is reported to be scaling down.

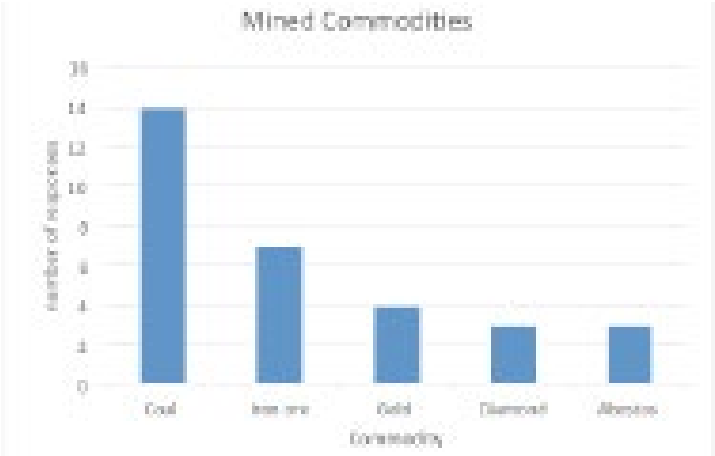
Health and legislation

The key informants indicated that, current miners receive TB, MDR TB and HIV health services from the mines through their collaboration with public health facilities and non-government organisation. Mine facilities such as the one in Maloma only offer screening to their employees, and patients are referred to the government clinics and hospitals for TB treatment. Families of the current miners receive their health services at the nearest government facility for a minimal fee. Unlike current miners, ex miners receive TB, MDR-TB and HIV health services from the government health facilities. One known non-government organisation which was donor depended used to offer TB treatment to ex miners for the duration of their project. However, once the project ended the ex miners had to rely on the state facilities for these services.

■ Figure 9.10
Key informants Sector of Employment



■ Figure 9.11
Most Commonly Mined Commodities, Reported by Key Informants



"For HIV we are getting support but our government does not have sufficient money to sustain such projects. The NGO's have their own terms and conditions which makes things a bit harder.…".

(KI096, Department of Health)

Although some informants perceived the health system of Swaziland to be adequate, most participants mentioned that there is still room for improvements. Although the country has a national referral system they still come across problem with tracing patients on the receiving side. One informant mentioned that the government health system relies strongly on donors supports. Lack of resources was one of the major highlighted problems during the interviews. Some of the challenges that were pointed out by informants included: lack of funds and diagnostic equipment for diseases such as silicosis; and medical doctors that are well informed and trained on the particular diseases. In addition, health facility are widely scattered resulting in patients having to travel long distance to access health services which results in problems such as defaulting on treatment.

Although, Swaziland has legislation on employee health and safety, they do not have specific legislation that focuses on the health and safety of mines and mine worker. Some informants reported that there have been some attempts to update the labour legislation act specifically on mineworkers and their health and safety. However, informants also stated that they are not well informed on the progress of the act being amended. Although, 11 out of 15 informants indicated that Swaziland have a compensation system in place for sick mineworkers with occupational disease; TB, MDR-TB and HIV are not considered as occupational diseases. Hence, some informants mentioned that those who get compensated are ex-miner who previously worked at South African mines. Hearing loss, blindness, asbestosis and injury on duty are some of the occupational disease that are compensated for in Swaziland.

Compensation only heard about the South African one I am not sure if there is one for Swaziland.

(KI098, Labour Union)

TB and MDR TB prevalence

The key informants perceived TB prevalence amongst miners to be higher compared to the general population. Some of the reasons given by informants were: lack of knowledge, poor living conditions, late diagnosis, harsh working conditions. Ex-miners are not seen as different to current miners as they are known to have worked in the same conditions as current miners. Moreover, high HIV prevalence amongst miners and ex miners predisposes them to TB.

Might be higher due to the working conditions and they contribute to the higher incidence and their environment.

(KI093, International Health and Developmental Organization)

There are cases of TB patients defaulting treatment. Some informants mentioned that poverty makes it rather difficult for patients to travel to clinics or health facilities to access treatment. Migration of people from one area to another also contributes to poor adherence to TB treatment, as referrals are at times poorly managed.

Most of the time it (TB adherence) is tempered with poverty and they end up not coming to the hospital...

(KI097, Department of Health)

At time I was there it was poor due to the migrating between South Africa and Swaziland.

(KI094, International Health and Developmental Organisation)

Silicosis in Swaziland is most likely to be misdiagnosed as TB. This is due to the fact that Swaziland's health system is not properlyl equipped with diagnostic tools and does not have adequetly trained staff to diagnose silicosis. Poor adherence to TB medication can result in the development of MDR-TB. There are also reported cases of defaulting on MDR-TB treatment due to the fear of toxic side-effects like hearing loss.

HIV prevalence

According to the interviewed informants Swaziland is a high burden HIV country. Based on the informant's reflections, HIV prevalence is higher among miners, ex-miners and their communities. Some of the stated risk factors included high rates of risky sexual behaviour and negative stigma associated with the disease. Some informants stated that limited health service from public health facilities makes it difficult for people to access health care timeously. An informant stated that HIV medication is better adhered to than MDR-TB and TB treatment.

"Prevention is offered there but there is not much resources available, facilities are there but there are far in most cases"

(KI096, International Health and Developmental Organization)

People do adhere to medication but it depends on allocation. Social determination.... employment and the level of education

(KI101, Department of Health)

Silicosis

There are few reported cases of silicosis in Swaziland. Based on the informant's perceptions, this is due to the fact that silicosis is mainly under diagnosed. In some cases silicosis is misdiagnosed as MDR-TB. According to 66% (6/9) of informants misdiagnosis is due lack of diagnostic tools, few facilities that offers silicosis screening, with only about three occupational health doctors in the country that can confidently diagnose the disease.

Silicosis is under diagnosed and it is not concentrated fully but other regions are concentrated on. Manzini has a better place to get medication and receive support.

(KI099, Researcher/Academia)

Summary of key findings

Swaziland is a landlocked state in Southern Africa. The country spends 9,3% of GDP on health and the life expectancy at birth is 49 years. HIV and TB are the main causes of death for men and women. The HIV prevalence for the general population is 29%. Women are disproportionally affected, especially the 15-35-year group with 31% HIV infected compared to 20% of men of the same age group. The ART programme has over 100 000 people currently receiving treatment. Although TB incidence has decreased over the years, it is still one of the highest in the world with a rate of 733/100 000. The proportion of MDR-TB is 7,7% in new cases.

Mining contributes 2% to the country's GDP and there is only one large scale company in Lubombo. Historically,

large numbers of Swazi miners used to work in South African mines. Although these numbers have decreased over the years there are still large numbers of Swazi miners employed in South Africa. In one study among miners 5% were found to have TB and of those 25% had MDR-TB. In another study, 20% of migrant miners who work in South Africa had HIV and 43% of their partners were also HIV infected.

Data gaps and findings

During the time of data review, there was little information on silicosis among miners in Swaziland. There is limited data on proportions of MDR-TB in the four districts. The region with the most mining activity which is also a labour-sending area (eastern Hhohho) has limited health indicators.

Conclusion and Recommendations

Swaziland has a long mining history and a high HIV and TB burden. However, there is little information on these diseases among miners. Therefore we recommend:

- Assistance to strengthen services for HIV/TB in the national health system.
- Implementing occupational health services at regions with the highest TB incidence, such as Manzini (a travel corridor).
- Health services in regions with the highest HIV prevalence: Hhohho (labour and mining) and high labour-sending area to South Africa, such as Shiselweni (labour).
- Implementing research programmes to collect data in high TB/HIV areas.

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The mining industry makes a significant contribution to the Tanzanian economy, mainly through the extraction of copper, gold, and silver, along with some industrial minerals and gemstones such as diamonds.

Chapter 10: **Tanzania**

Executive Summary

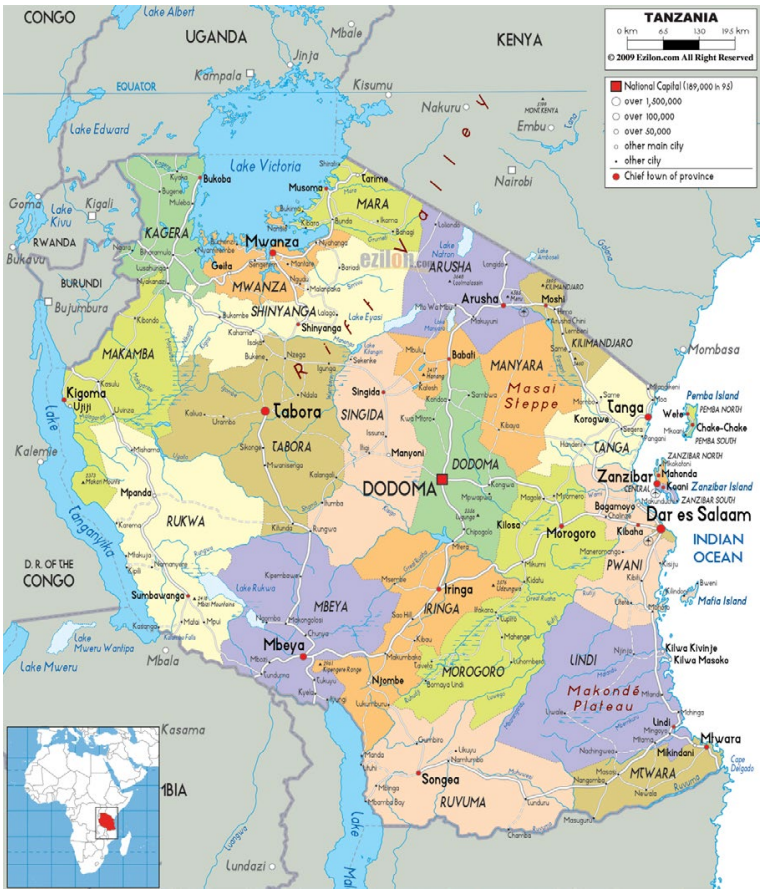
Background: Tanzania is a low-income country, with 68% of its people living below the poverty line. The country has achieved financial growth due to its enormous natural resources and tourism, and has had GDP growth of 6%-7% since 2009. Agriculture accounts for more than one quarter of GDP while mining contributes 2,5%. The country is divided into 30 regions and 131 districts. The mining industry in Tanzania is mostly small-scale and artisanal and employs over a million people compared to 15 000 in large-scale mining. The primary mined commodities in Tanzania are gold, tanzanite and diamonds. The Geita region is the main gold-mining area.

Key findings: Tanzania has a high TB burden (327 per 100 000). Strikingly, there is a lower TB incidence in Geita region (265 per 100 000). Silica exposure in most of the ASM gold miners exceeds the recommended limits. HIV prevalence in ASM miners is 8,9% and silicosis prevalence is 1,6%. HIV prevalence is higher among non-mine workers at 22,9%, peri-mining communities (16-18% for both males and females) and sex workers (42%).

Limitations: There are wide discrepancies between international and country specific reports on TB and HIV among miners and current epidemiological studies are recommended. We were also unable to access district level TB data for this report.

Recommendations: OHS services in Tanzania should be mainly targeted at artisanal and small-scale miners.

Figure 10.1
Map of Tanzania



Introduction

Tanzania, also known as the United Republic of Tanzania, is in the Eastern part of Africa, and the capital city is Dodoma though the largest and best-known city is Dar es Salaam. It borders eight countries (Figure 10.1): Burundi, Democratic Republic of Congo, Kenya, Malawi, Mozambique, Rwanda, Uganda and Zambia. Swahili or Kiswahili and English are the official languages. Tanzania has a population of 52-million people, 44% of whom are between the ages of 0-14 years (Table 10.1), and only 3% are above the age of 65 years. Life expectancy at birth is estimated at 61,7 years. Most Tanzanians (68,4%) live in rural areas, and 67,9% live below the poverty line. The gross domestic product per capita is US$354[1]. The country is divided into 30 regions and 131 districts and the biggest regions by population size are Dar es Salaam, Dodoma, Mbeya, Morogoro, Mwanza, Tabora, Tanga and Kigoma[1,2].

Tanzania is a low-income country, but has achieved high growth rates due to its enormous natural resources and tourism, with GDP growth of 6%-7% since 2009. Agriculture accounts for more than a quarter of the GDP, and provides 85% of exports. Other industries include mining (diamonds, iron and gold), cement, salt soda and oil refining[1].

General Health Indicators

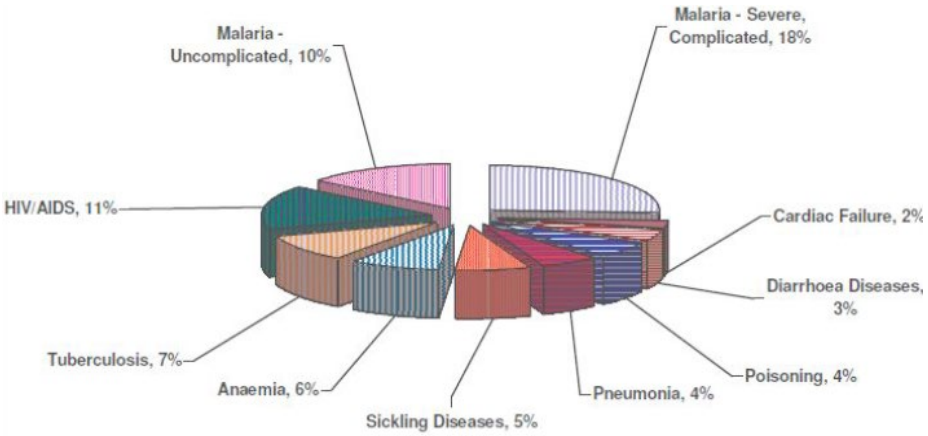
Health outcomes in Tanzania have been improving in the last few years, which is evident in the improved life expectancy at birth. Child mortality has reduced, to 81 per 1 000 live births, although neonatal mortality is declining at a slower pace, with most of the deaths occurring in the first month of life in children. The gap between urban and rural child mortality has decreased. The decline in HIV-related deaths has also resulted in a reduction in overall mortality in adults. HIV prevalence has dropped from 84% in 1996 to 5,1% in 2011. Some of the leading causes of mortality in adults are: tuberculosis, outbreaks in new or re-emerging conditions like dengue fever, tropical diseases, as well as cancer, diabetes cardiovascular diseases and road accidents (Figure 10.2)[2].

The health determinants that contribute to some of the poor health outcomes are malnutrition, shortage of safe drinking water and poor sanitation[2]. Tanzania's health

Table 10.1 General Health Indicators – Tanzania *[World Factbook - Tanzania]*

Population	**52 million**
Proportion 0-14 years	44%
Life Expectancy at Birth	61 years
Neonatal Mortality rate	21 per 1000 live births
Under 5 mortality rate	54 per 1000 live births
Maternal Mortality ratio	460 per 100 000 live births
Physician Density	0,006 per 1000
Nurse Density	0,008 per 1000
Total Expenditure on Health	7,3% of GDP

Figure 10.2
Top ten causes of mortality in Tanzania
[Source: World Health Organization, 2016]



system is complex and suffers from a shortage of qualified personnel and limited financial resources. Table 10.2 indicates that the shortages of healthcare workers of different cadres can vary from 33% for nursing officers to 58,1% for specialist doctors[3]. Adding to this problem are maladministration, poor remuneration, inadequate infrastructure and low output of qualified staff[3]. The shortages are more pronounced in lower level facilities and more remote areas and this could be alleviated by increasing attractive retention schemes and improved distribution of health personnel[3].

Mining Landscape

The mining industry of Tanzania provides jobs for over one million people, mostly in small-scale and artisanal mining (ASM)[4]. For example, as of 2011, 50 000 artisanal miners were involved in mining coloured gemstones. In 2015 the World Bank offered Tanzania a US$45-million loan to improve the small-scale mining industry in rural Tanzania[2]. The mining industry makes a significant contribution to the Tanzanian economy, mainly through the extraction of copper, gold, and silver, along with some industrial minerals and gemstones such as diamonds[1]. International mining companies dominate the industry in the extraction of gold and diamonds, with additional small-scale mining operations scattered across the country. Tanzania is the fourth-largest gold miner in Africa behind South Africa, Mali, and Ghana[4]. There are more artisanal small-scale miners compared to people employed in formal large scale mines[4]. The collapse of other industries in the country, as well as the geological characteristic of the minerals that make it easy to mine with simple tools, and political influence have contributed to the increase in artisanal and small-scale miners[4].

Results

General Population TB and HIV Epidemiology

Tanzania has a high TB burden with an incidence of 327/100 000[5]. The proportion of MDR-TB was 1,1% in new cases and 3,1% in retreatment cases (Table 10.3)[5]. A total of 91% of TB patients were tested for HIV. Of these, 35% were HIV infected and 83% of them were accessing ART. However, HIV/TB coinfection is mostly found in

■ **Table 10.2 Status of healthcare workers by cadre in Tanzania**
[Source: USAID Tanzania Health System Assesment, 2010]

Cadre	Establishment	Available	Deficit	%Deficit
Specialist doctors	229		133	58,1%
Nurse/NW/PHNII	20 373	9,2	11,1	54,6%
Radiographer	197	97	100	50,8%
Clinical Officers	11 316	5 655	5 661	50,0%
Pharmacist/technician	621	311	310	49,9%
AMO/ADO	2 407	1 295	1 112	46,2%
Health Officers	1 823	990	833	45,7%
Laboratory technician	821	480	341	41,5%
Ass. Clinical officers/MCH aide	760	451	309	40,7%
Medical doctors	748	469	279	37,3%
Nursing officers/PHNA	6 559	4 381	2 178	33,2%
Health secretaries	269	196	73	27,1%
Others/medical attendants	24 154	18 891	5 263	21,8%
Total	70 277	42 553	27 724	39,4%

people aged 25-34 and 45-54 years (Figure 10.3)[6].

TB incidence has been decreasing in Tanzania, peaking in 2002 with an incidence of 510/100 000 (Figure 10.4)[7]. Men are the most affected by TB, especially in the age group 25-54 years (Figure 10.5)[6].

TB notification rates vary by regions but the numbers reported in the 2014 National TB and Leprosy programme annual report differ from those reported by WHO. For example, the WHO reports the TB prevalence for Tanzania to be 327/100 000 while the country report estimates it to be below 150/100 000 (Figure 10.6)[6]. Nevertheless, based on the country report the districts with the highest rate of TB are: Dar Temeke, Dar Es Salaam and Dar Kinondoni.

Around 1,4-million people are infected with HIV in Tanzania and the overall prevalence is 3%[8]. Among people aged 15-49 years the HIV prevalence is 4,5%[8]. During the period 2003/4 to 2011/12, the HIV prevalence in Tanzania declined from 7,0% to 5,3% among adults aged 15-49.[2] The Tanzanian mainland experiences an advanced generalized HIV epidemic while in Zanzibar the epidemic

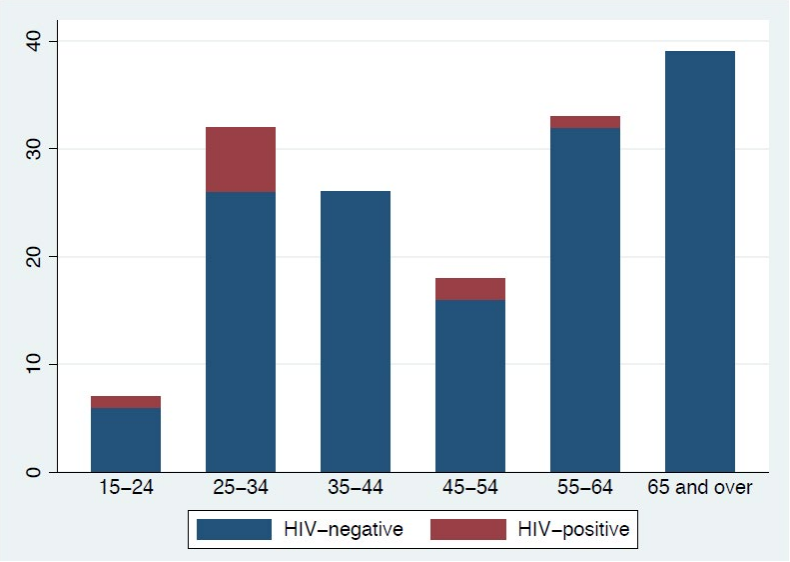
Table 10.3 Estimates of TB Burden 2014 in Tanzania *[Source: World Health Organziation]*

Estimates of TB Burdern 2014	Number(thousands)	Rate (per 100 000 population)
Mortality (excludes HIV+TB	30 (13-54)	58 (26-104)
Mortality (HIV+TB only)	28 (15-43)	53 (30-84)
Prevalence (includes HIV+TB)	270 (110-510)	528 (215-979)
Incidence (includes HIV+TB)	170 (80-290)	327 (155-561)
Incidence(HIV+TB only)	62 (29-110)	120 (56-208)
Case dectection, all forms (%)	36 (21-77)	
Estimates of MDR-TB burden 2014	New	Retreatment
% of TB cases with MDR-TB	1.1 (0.5-2)	3.1 (0.9-7.9)
MDR-TB cases among notified pulmonary TB cases	83 (11-330)	530 (270-910)
TB case notifications 2014	New	Relapse
Pulmonary, bacteriologically confirmed	25 583	1 008
Pulmonary, clinically diagnosed	23 380	
Extrapulmonary	13 600	

Figure 10.3

Distribution by age and HIV status of 155 bacteriologically confirmed prevalent TB cases

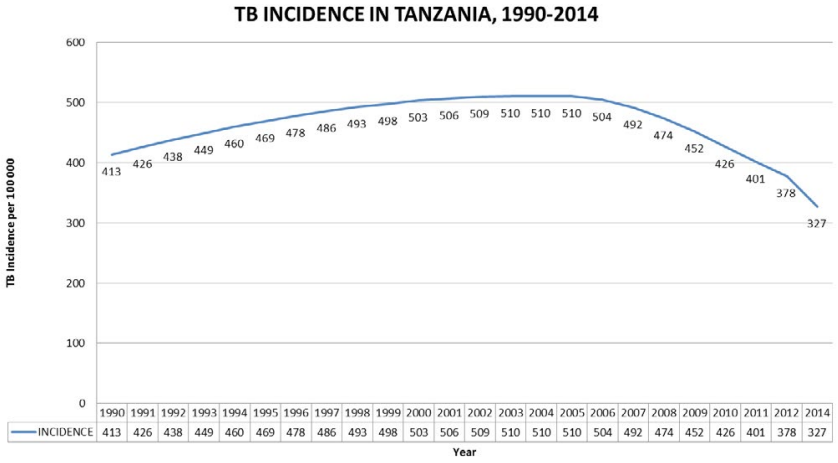
[National TB and Leprosy Programme Annual Report, 2014]



■ **Figure 10.4**

TB Incidence in Tanzania from 1990-2014

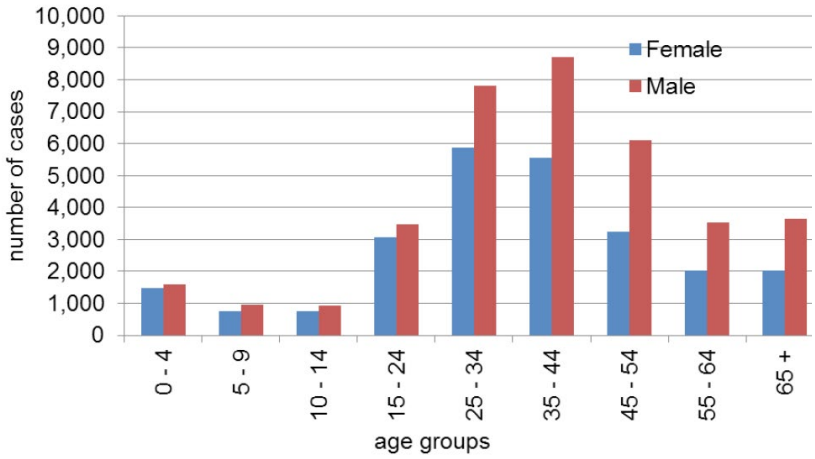
[Source: WorldBank: Incidence of TB]



■ **Figure 10.5**

Age and sex distribution of new bacteriologically confirmed TB cases notified in 2013

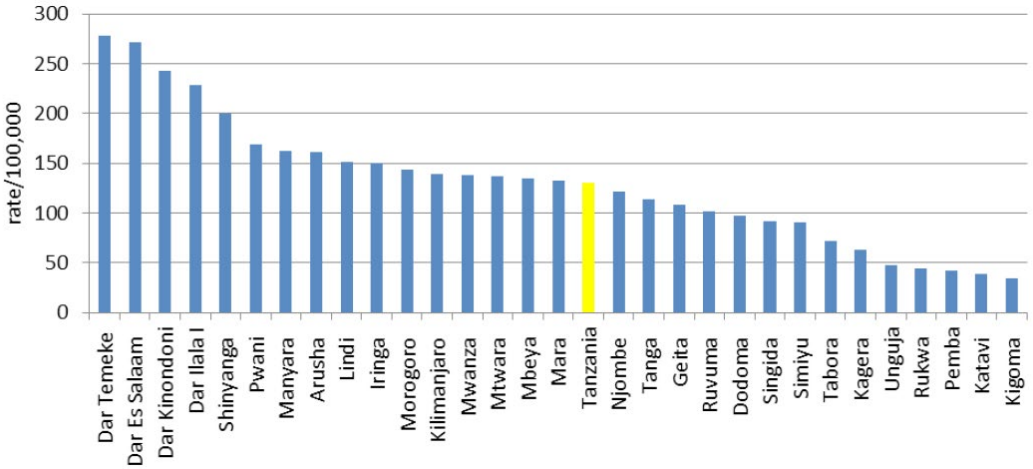
[Source: WorldBank: Incidence of TB]



■ **Figure 10.6**

TB notification rate (new and relapse) by region for 2014

[National TB and Leprosy Programme Annual Report, 2014]



remains largely concentrated in key populations[1]. A statistically significant decline was observed among men in the 15-49-year-age group from 6,3% to 3,9% but not among women (Figure 10.7)[7]. Population groups at high risk of HIV infection are men who have sex with men (22,2%); people who inject drugs (16%); migrant/ mobile workers, female sex workers (31,4%); and miners. Women are also disproportionately affected by the epidemic: HIV prevalence of 1% among 15-19 year-olds increases to 10% among women aged 45-49 years (Figure 10.8). Some of the primary reasons that women are more affected than men is that they have older sexual partners and cannot negotiate safer sexual practices[8]. HIV prevalence varies by regions, with Njombe having the highest (14,8%), and Manyara the lowest (1,5%) HIV prevalence. Some regions (Ruvuma, Kagera, Kigoma, Mtwara) have reported a decrease while Singidi and Arusha have reported an increase in HIV prevalence[2].

HIV testing has been scaled up in the last few years by increasing the number of facilities that offer this service. It is estimated that 37% of HIV-infected people are accessing antiretroviral treatment through the 1 209 health facilities that offer ART[2]. In terms of prevention of mother to child transmission (PMTCT), 77% of eligible pregnant mothers were accessing ART in 2013 but nearly one fifth of children who have HIV are infected because of mother-to-child transmission. UNAIDS reported 36 000 deaths from AIDS in 2015[9].

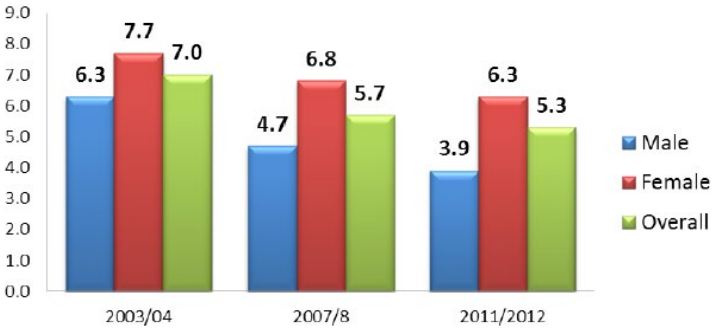
Miners TB, HIV and Silicosis Data

The main mining areas (large-scale formal and informal mines) in Tanzania are Geita Region, Mererani Town and Kishapu District. These areas have high rates of TB (138-865/100 000)[10]. Geita has an incidence of 265/100 000[10]. Mine workers are at higher risk of TB due to: exposure to silica and dust, poor working and living conditions and a lack of TB prevention and education services. Added to these factors are others associated with migration, such as a lack of social support structures and the inability to access or afford health services. The prevalence of the disease, especially in small-scale miners, erodes the positive contribution made by the sector to Tanzania's economic development[11].

■ **Figure 10.7**

HIV Prevalence by age and sex among adults aged 15-49 years

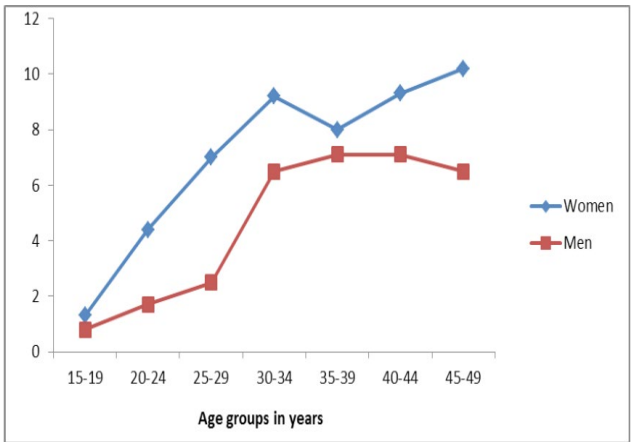
[Source: Garbius 2004]



■ **Figure 10.8**

HIV Prevalence by age groups and sex among adults aged 15-49 years

[Source: Garbius 2004]

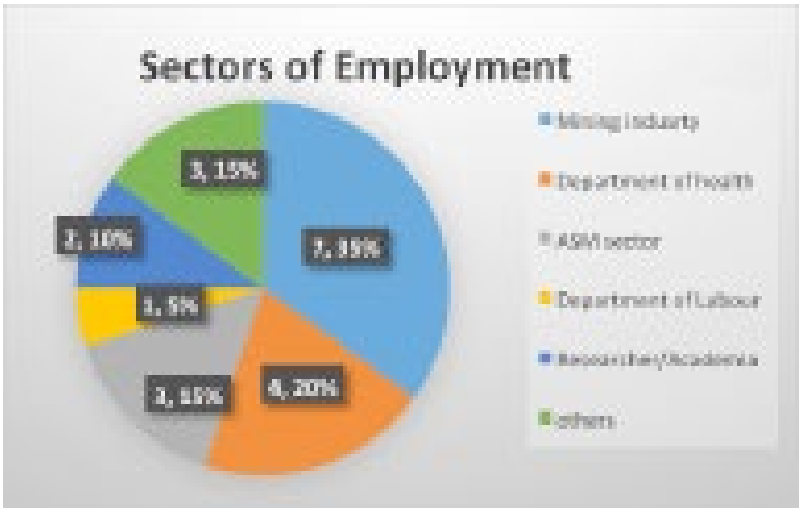


Published Literature

Table 10.4 Summary of Published Literature on Miners Health in Tanzania

Reference	Methodology	Results and Comments
2015 **Gottesfeld et al.**[12]	Gold miners from 5 villages	Airborne crystalline silica exposures exceeded recommended limits for all tasks monitored, with an average exposure of 16,85 mg/m3 for underground drilling that was 337-fold greater than the recommended exposure limit (REL)
2015 **Mpagama et al.**[13]	Gold ASM miners from Mererani	HIV Prevalence: 8,9%. Silicosis Prevalence: 1,6%. HIV prevalence was higher in non-miners at 22,9%. In summary, most patients prescribed a retreatment regimen were admitted for relapse after recent TB treatment, and while nearly 25% had a history of mining as their primary occupation, miners were less likely to be HIV infected and appeared not at increased risk of poor outcome from retreatment.
2003 **Clift et al.**[14]	Cross-sectional survey with gold miners and mining communities in the Kakola, Mwanza and Shinyanga Regions	HIV Prevalence: 8,7% (miners). HIV prevalence in general community: men 16%, women 18%. Female sex workers' HIV prevalence was 42%.
2016 **Mayala et al.**[15]	Assessment of mining ventilation systems and pollution	TB Prevalence in Miners – 6,6%. Exposure to silica dust of 4 000 artisanal tanzanite miners is 2,5 times higher than the maximum concentration specified by Ontario Ministry of Labour. Only 10% of miners work with masks.
2013 **Charles et al.**[16]	Cross-sectional survey of gold ASM miners in Geita District	Many (89,4%) are not aware of the health effects of mercury and arsenic exposure. Lack of knowledge, combined with minimal environmental monitoring and controlled waste management practices, highlights the need for health education, surveillance and policy changes.
2010 **Bose-O'Reilly** [17]	Surveillance of ASM gold miners in Rwamagasa Geita District	Mercury concentrations levels were high in ASM miners. Amalgam burners were found to be at risk of being poisoned.

Figure 10.9
Key Informants Sector of Employment



Perceptions of Key Informants

Population Description

A total of 20 key informants from Tanzania were interviewed for the TIMS project. The informants were based in Manyara (5), Dar es Salaam (5), Shinyanga (3), Mwanza, Geita, and Arusha region. Key Informants represented various sectors of employment: Mining Industry (7), ASM Sector (3), Ministry of Health (4), Ministry of labour and employment (1), Researchers/ Academia (2), International Health and Development Org (WHO, MSF, ILO) and others (Figure 10.9). Most of them were medical practitioners, social services, sociologist and lawyers. The median duration of key informants in their current role was 5 years. The median age of the key informants was 40 years (IQR: 34- 56).

Mining

Most key informants had a good grasp of mining activities happening in the country and health issues surrounding miners and their communities. The most commonly reported mine activity in Tanzania was underground and quarrying. Gold, Tanzanite, Diamonds, Uranium, Coals, and Iron Ore were perceived to be the most mined commodities. Top five mining companies mentioned by Key Informants included Acacia Mine, Geita Gold Mine, North Mara Gold Mine, Williamson Diamonds Mmine and Tanzanite One Limited. These mines are located under different regions: Geita, Shinyanga, Maranya, Mara and Mbeya.

■ **Table 10.5** Available Health Services in Tanzania

	Current Miners		Ex-miners	
TB	**Current Miners**	**Communities**	**Ex-miners local**	**Ex-miners Outsiders**
Screening	19	18	14	7
Prevention	16	8	10	8
Treatment	19	18	14	8
MDR TB				
Screening	12	10	6	6
Prevention	10	10	4	6
Treatment	9	9	5	8
HIV				
Screening	17	18	13	8
Prevention	4	2	0	0
MMC	12	12	11	6
Treatment	16	16	6	3
Silicosis				
Screening	6	1	2	4
Prevention	3	1	1	3
Support	4	1	1	4
Public Health	14	7	17	
NGO	5	5	11	
Mine Occupational Health Services	10	2	1	

Health Services

Most key informants were mainly aware of the health services that were provided for miners, ex-miners and their communities (Table 10.5). Key Informants perceived TB (screening, prevention and treatment) and HIV (screening, MMC and treatment) services to be the common accessible services to current miners and local ex-miners in Tanzania. There was low responses towards the accessibility of silicosis health services to current miner and ex-miners. Public health services was the most mentioned point of care for both miners and ex-miners and their communities, followed by the mine occupational health service for current miners. Informants also stated that local ex-miners access health services mainly from public health service and non-government organisations. Some of the Key Informants (6/13) mentioned that only few mines such as Geita, Acacia and Williamson offers health services to their employees. Mine clinics are also perceived to work in collaboration with the government and national programs. However, some informants claim that families of miners rely on the regional and local clinics for health services as mines only accommodate their employees. Half of the informants mentioned that ex-miners are not catered for in the mining clinics as they are not categorised as miners therefore they access health care services like the general population.

"There is no categorical group of ex-miners. 2. Ex-miners receive treatment from government hospital, which is available within their communities like any member of those communities.... "'

(KI106, ASM sector)

"Only large-scale mining companies have organized services for its employees, either through their clinics or government health facilities. Acacia and North Mara Gold mines have good health facilities. For miners in small mining companies such services are only possible through government facilities".

(KI116, Social Work Local Government)

HealthSystem

Majority of the informants (13/16) perceived the health system of Tanzania to be problematic due an unregulated system, unavailability of drugs (medication), limited occupational health care points , lack of medical diagnostic equipment and poor health infrastructures. Most informants are unaware of a workers compensation system available for miners and ex-miners with TB, MDR TB, and/or HIV. Most key informants indicated that should a miner be declared sick they are entitled to paid sick leave. However, half of the informants (6/11), commented that it depends on the employer. Artisanal and small-scale miners have no sick leave compared to most large mining companies. In ASM, managers and supervisor are the one that usually determine that one is sick whereas in large mining companies a qualified medical practitioner determines that one is sick and suggest sick leave.

"Availability of treatment drugs is not proportional with number of miners that require treatment. Therefore, there are delays in distribution of drugs from time to time. Diagnostic equipment, such as X-ray, MRI and CT scans, are located more than 40 kilometres away which makes it difficult to test occupational diseases."

(KI106, ASM sector)

Health and Safety Legislation

About 90% of the informants are aware of existing health and safety legislation. The legislation state the basic health rights of every employees including miners. Although some believe that the legislation is annually updated, marority (13/15) of informants state that the legislation is somehow followed. Injuries at work, skin disease, eyesight loss and hearing loss are commonly known sickness that are usually compensated in Tanzania.

"Accident in mining and skin diseases the government has started a fund known as the Workers Compensation Fund (WCF) Companies also have their own way of providing compensation but also follows the stipulations of labour laws it is difficult to establish that diseases such as TB and HIV are caused at/by work"

(KI118, Mining Industry)

"The policy argues that health is paramount in the mining sector. Therefore, the provision of basic health is required and safety measures are followed to some extent. However, the policy is silent about procedures and measure to prevent occupational diseases."

(KI107, Mining Industry)

TB and MDR TB prevalence

13/19 informants perceived TB prevalence to be high amongst current mine workers. Miners are considered as a high risk population due to their harsh working conditions, poor living conditions and lack of knowledge resulting in late detection of diseases. Three informants identified Mererani region to be the most affected area in the Kimanjiro district. Majority of the informants had no information with regards to TB amongst ex-miner. Some claimed that there is no database for ex-miners in the country. Key informants reported challenges to TB medication adherence among miners. There is a presumption that TB medication requires a healthy diet which seems problematics as many miners are unable to achieve this. Although there are some concerns of MDR-TB in Tanzania, key informants stated that they are rare reported cases.

"In the statistics for the year 2016, out of 310 cases that were identified to be of TB, 209 were from Mererani and out of these 180 were males. Also, 150 out of 180 were miners or ex-miners..."

(KI120, Ministry of Health)

HIV prevalence

There is high perceived HIV prevalence amongst mine workers and their surrounding communities. Mererani in Simanjiro district and Kahama in Shinyanga Region are perceived to be the most affected areas. Approximately (3/19) informants stated that it is high amongst artisanal small-scale miners compared to large scale mining companies. The high prevalence rate are believed to be due to unsafe sexual practices, multiple sexual partners, alcohol abuse, lack of treatment and care

"Tanzania has a comprehensive national campaign and clinics addressing the HIV/AIDs epidemic. The only challenge is the accessibility of medication and screening in rural areas"

(KI104, Mining Industry)

"The case of HIV in mining community is quite high due to the nature of the industry itself of which miners are predominantly male and their sexual needs are met by women found in communities residing around the mines".

(KI105, International Health and Development Organisation)

Silicosis

Although some participants are aware of silicosis and its occurrence amongst miners , more than 50% of Key Informants acknowledged that Tanzania has less reported cases of silicosis due to lack of diagnostic equipment.

"No information on the burden of silicosis among miners due to inadequate capacity among Health Care Workers (HCWs) to diagnosis silicosis".

(KI112, Ministry of Health)

Summary of Key Findings

Tanzania is a low-income country with a life expectancy of 61 years at birth. The major causes of mortality are malaria, HIV/AIDS and TB. Most mine workers in Tanzania work in the artisanal and small-scale mining sector. The TB prevalence in miners varies from 138-6 600 per 100 000. The country's TB incidence is 327/100 000 with MDR-TB prevalence of 1,1% in new cases of TB. HIV prevalence varies by regions, with Njombe having the highest and Manyara the lowest. The overall HIV prevalence is 3% and is 4,5% among people aged 15-49 years. TB/HIV coinfection among TB patients is 35%, which is low compared to other Southern African countries such as Zimbabwe with 71%. TB affects mostly males in the age group 25-54 years. Although there are discrepancies in the data, TB incidence varies by region. In some reports Geita mining area has one of the highest TB incidence, in others it is similar to the country level. Published literature has shown that gold mine workers are exposed to high levels of silica dust, with a silicosis prevalence of 1,6%. HIV prevalence in mine workers is estimated at 9%, three times higher than the general population. TB prevalence in miners was 6,6% which is almost 20 times higher than the general population.

Data Gaps and Limitations

Although some studies have been done on the burden of TB and HIV among mine workers and their communities, there is diversity in the reported prevalence rates between international reports and country-specific reports. Most miners are artisanal and small-scale. Some are not documented and might not have been included in all the studies. We were unable to access district level TB data for this report.

Conclusion

The mining industry makes a significant contribution to the Tanzanian economy. Tanzania has both formal large-scale mines and artisanal and small-scale mines (ASM). Most mine workers are employed in the ASM sectors. Although HIV prevalence is lower than in other Southern African countries, there is enough evidence that mine workers are exposed to high levels of silica dust, and have high HIV and TB prevalence. ASM miners do not have healthcare services while formal large-scale mines do provide some health services to their employees. Therefore, ASM should be the focus of occupational health interventions. The Interventions should be focused more in the Geita and Kahama districts where most of the mines are located.

Recommendations

- Map mine workers and enhance understanding internal and external migration.
- Undertake large-scale studies of TB, HIV and silicosis among mine workers to establish more accurate rates.
- Do more studies of artisanal and small-scale mining to better understand the sector and its associated health implications.

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Zambia is Africa's largest producer of Copper and Cobalt. Other commodities mined in Zambia include lead, zinc, silver, gold, emeralds and coal. By the end of 2014, Zambian mine employment figures had stabilised around 70 0008.

Chapter 11: **Zambia**

EXECUTIVE SUMMARY

Background: Zambia is a lower-middle income country in Southern Africa. The country has high rates of urbanization within the main urban provinces of Lusaka and the Copperbelt. These two provinces have the highest levels of mining activity. Copper mining is a major driver of Zambia's recent economic growth. The high levels of urbanization have led to inequalities in the population, with rural areas facing higher levels of poverty while **urban areas face higher rates of TB and HIV.**

Key findings: Zambia is regarded as a high TB burden country. Rates of TB are disproportionately higher in mining districts, for example, Ndola and Kitwe (2294 per 100 000) compared to the general population (436 per 100 000). The TB epidemic mirrors the HIV/AIDS epidemic. Again, HIV/AIDS prevalence is higher in mining provinces (18,2% and 16,3% in the Copperbelt and Lusaka) compared to the country estimate (13.5%). Health services for current miners are available through mine health facilities while ex-miners and peri-mining communities access care through state facilities. Adequate legislation exists which protects miner's health and provides for compensation for occupational lung disease. However, reports from key stakeholders reflect a lack of awareness among miners on the available compensation.

Limitations: Current data on the burden of HIV, MDR-TB and silicosis among miners and ex-miners is limited.

Recommendations: Occupational health surveillance of miners with a focus on migrant, illegal and ex-miners in the country will inform the location of OHS centres.

■ Figure 11.1
Map of Zambia
[Source Ezilon.com]

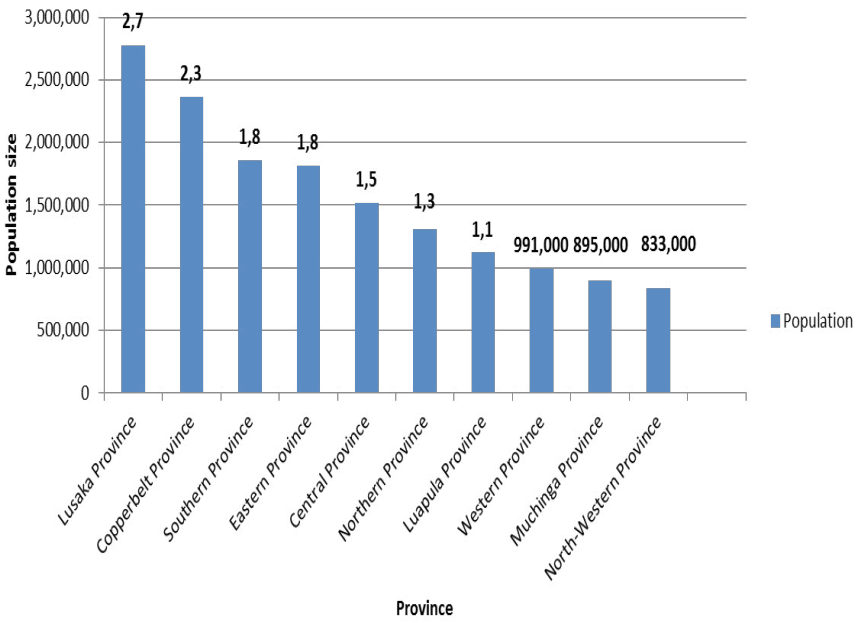
Introduction

Zambia is classified as a lower-middle income country[1]. The country's economy is vested mainly in copper mining, as well as the agriculture, construction, transport and communication sectors[2]. Zambia has had consistent economic growth over the past 10 years. Despite the strong economic growth, high rates of poverty and unemployment levels persist, mainly in the rural areas[2]. Poverty levels were estimated as 77,9% in rural areas compared to 27,5% in urban areas in 2010[2]. These high poverty levels are driven in part by the high birth rate, high burden of HIV/AIDS and poor economic policies[3].

General health indicators

Life expectancy at birth improved from 50 years in 2000 to 61,8 years in 2015 (Table 11.1)[4,5]. The under-five mortality rate decreased from 168 per 1 000 live births in 2001 to 64 in 2015.[4,5] The neonatal mortality rate decreased from 34 per 1 000 live births in 2007 to 21,4 per 1 000 live births in 2015[4,5]. The maternal mortality rate improved from 729 per 100 000 live births in 2001/2 to 224 per 100 000 live births in 2015[4,5]. Zambia is on track to meet the targets for Millennium Development Goals (MDG) 6 ("Combat HIV/AIDS, malaria and other diseases") but has made insufficient progress to meet the targets for MDG 4 ("Reduce child mortality") and 5 ("Improve maternal health"). The country is vulnerable to natural disasters such as droughts and floods that affect agricultural production and contribute to high levels of malnutrition in the country.[5]

■ **Figure 11.2**
Zambian population by province
[Zambia census]



■ **Table 11.1 Current Health Indicators 2015** *[Source WHO]*

HEALTH INDICATOR	
Total population in thousands (2015)	16211,8
% Population under 15 (2015)	45,9%
% Population over 60 (2015)	4,3%
Life expectancy at birth (2015)	59,0 (Male), 64,7 (Female), 61,8 (Both sexes)
Neonatal mortality rate per 1 000 live births (2015)	21,4 [16,0-28,5]
Under-five mortality rate per 1 000 live births (2015)	64,0 [49,4-81,3]
Maternal mortality ratio per 100 000 live births (2015)	224 [162 - 306]

The Zambian government aims to ensure that facilities are within reach of communities to increase access to primary healthcare services. The Ministries of Health (MoH), Community Development and Mother and Child Health (MCDMCH)[5] are working together to achieve this objective. Access to health services is greater in the urban areas (Lusaka and Copperbelt) with 33% (37/109) of the hospitals located in these regions (Table 11.2)[6]. However, primary healthcare facilities in rural provinces (1 131) outnumber those in urban areas (409) (Table11. 2). The government owns 81% (1 590/1 956) of the facilities in the country, 13% (250/1956) are owned by private health facilities and 6% (116/1956) are owned by faith-based health organisations. In total, 25 806 beds and 3 446 cots are recorded[6].

Mining landscape

Zambia is Africa's largest producer of Copper and Cobalt[7]. Mining activities are mainly focused in the Copperbelt and Northwestern provinces, which contain the highest-grade copper and cobalt deposits in the world[7]. Although copper production was affected by low copper prices in the late 1990s, production more than doubled from 2000 to 2007, from 256 884 tons to 572 793 tons, and is expected to reach 1 500 000 tons by 2018[2]. Other commodities mined in Zambia include lead, zinc, silver, gold, emeralds and coal. By the end of 2014, Zambian mine employment figures had stabilised around 70 000[8]. Figure 11.3 shows the top mining companies by number of employees, with Mopani reported as the biggest employer[9].

Table 11.2 Summary background statistics for health facilities by Province, Zambia, 2012 *[Source- Zambia MoH]*

No.	District name	No. of HF by levels of care							No. of HF by ownership				No. of beds & cots	
		No. of TLH	No. of SLH	No. of FLH	No. UHCs	No. of RHCs	No. of HPs	Total HFs	No. of GRZ HFs	No. of Mission HFs	No. of Private HFs	Total HFs	Number of beds	Number of cots
1	Central	0	2	8	29	129	36	204	185	9	10	204	1,984	195
2	Copperbelt	3	4	11	148	55	29	250	172	10	68	250	4,560	734
3	Eastern	0	2	7	5	143	49	206	193	13	0	206	3,216	309
4	Luapula	0	1	6	3	125	10	145	138	6	1	145	1,818	290
5	Lusaka	3	1	15	182	51	42	294	126	13	155	294	2,942	537
6	Muchinga	0	1	4	4	69	21	99	89	7	3	99	1,194	90
7	Northern	0	2	2	8	102	34	148	139	6	3	148	1860	133
8	North-Western	0	1	10	6	135	11	163	143	18	2	163	2,696	227
9	Southern	0	4	11	19	178	41	253	227	18	8	253	3,400	652
10	Western	0	1	10	5	144	34	194	178	16	0	194	2,136	279
Zambia		6	19	84	409	1,131	307	1,956	1,590	116	250	1,956	25,806	3,446

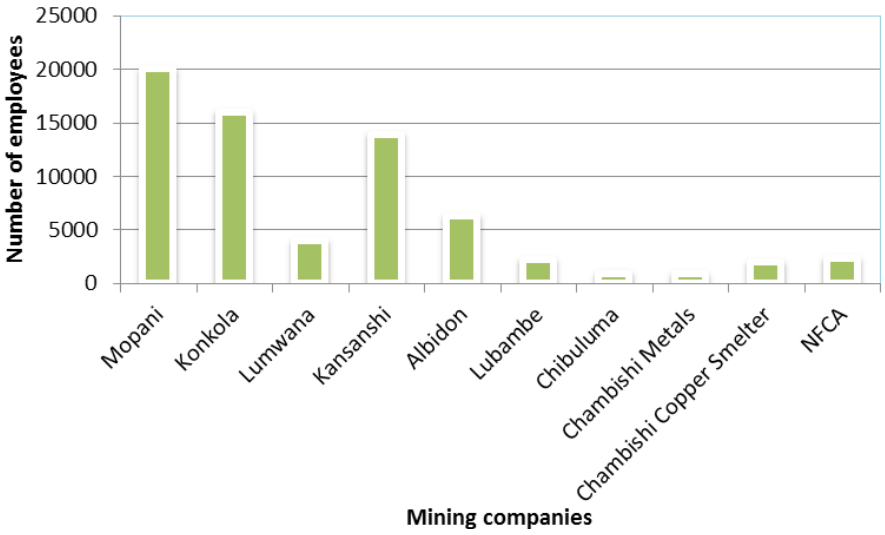
Results

General Population TB and HIV Epi Data

Tuberculosis in Zambia is a major public health problem and the country is classified as one of the high TB burden countries[10]. As of 2014, the overall TB incidence in the general population is 406 per 100 000 (Table 11.3)[10]. The overall TB prevalence rate is 436 per 100 000.[4] However, the TB incidence rate has been declining over the years, from an earlier peak of 847/100,000 in 1995 possibly due to an increase in ARV coverage. TB notification rates are highest in the provinces of Lusaka and Copperbelt (Figure 11.4). These provinces represent urban and mining communities and are also on the main railway routes. Based on the WHO TB Report (2015), the burden of TB and MDR-TB indicated a 59% case-detection rate for all forms of TB, with 42 716 notified cases of TB in 2014 (Table 11.3)[4]. The highest prevalence of TB is found among people aged 25-44 years (Figure 11.5)[10]. The risk of getting TB is twice as high for men than women. The estimated incidence rate of MDR-TB in 2015 was 14 per 100 000 (0,3%)[11]. Zambia is recognised as one of the high-burden countries by WHO for TB/HIV co-infection, with a prevalence ranging from 60%-70% (Table 11.4). Out of the 42 716 notified TB cases in 2014, 93% (39 763) have a known HIV status. From the cases with a known HIV status, 61% (24 198) are co-infected with TB and HIV. Of the co-infected cases, 73% (17 611) are on ART and 91% (21 929) are on cotrimoxazole (Table 11.4 and Figure11.6)[12].

■ **Figure 11.3**
Mining companies in Zambia with number of employees (2014)
[Zambia Chamber of Mines]

Mining company	Employees	Contract Workers	Total
Mopani	10 000	10 000	20 000
Konkola	7 000	9 000	16 000
Lumwana	1 882	2 054	3 936
Kansanshi	4 781	9 138	13 919
Albidon	6 300		6 300
Lubambe	1 200	1 000	2 200
Chibuluma	602	345	947
Chambishi Metals	741	147	888
Chambishi Copper Smelter	1 600	400	2000
NFCA	1 064	1 219	2 283
Total	**35 170**	**33 303**	**68 473**



■ **Table 11.3** Estimates of TB and MDR-TB *[Source WHO]*

Estimates of MDR-TB burdern 2014	New	Retreatment
% of TB cases with MDR-TB	7.7 (4.8-11)	34(28-39)
MDR-TB cases among notified pulmonary TB cases	320(200-440)	120(100-140)

Estimates of TB Burdern 2014	Number(thousands)	Rate (per 100 000 population)
Mortality (excludes HIV+TB	5.1 (3.1-7.5)	32 (20-48)
Mortality (HIV+TB only)	11(7.4-16)	74 (47-102)
Prevalence (includes HIV+TB)	69 (38-110)	436 (241-688)
Incidence (includes HIV+TB)	64 (44-88)	406 (279-557)
Incidence(HIV+TB only)	38 (25-52)	239 (162-331)

Case dectection, all forms (%)	59(43-86)	

Estimates of MDR-TB burden 2014	New	Retreatment
% of TB cases with MDR-TB	0.3 (0.04-1.2)	8.1 (4.1-14)
MDR-TB cases among notified pulmonary TB cases	83 (11-330)	530 (270-910)

TB case notifications 2014		New	Relapse
Pulmonary, bacteriologically confirmed		12070	1709
Pulmonary, clinically diagnosed		15568	
Extrapulmonary		8584	

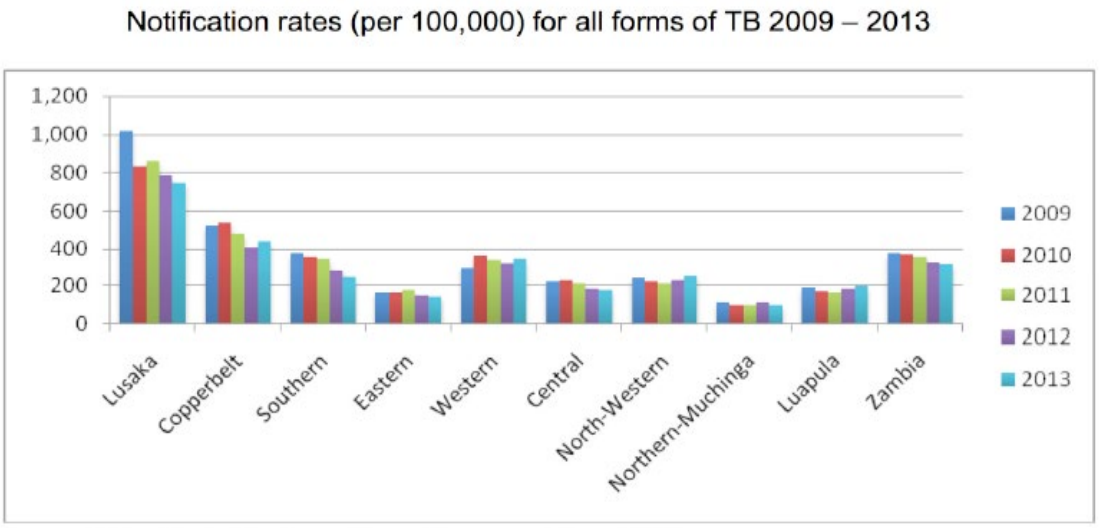
Total New and relapse		37931
Previously treated, excluding relapse		4785
Total cases notified		42716

Among 36222 new and relapse cases: 2726(8%) cases aged under 15 years male: female ratio: 1.5

■ **Figure 11. 4**

Trends in TB Notification Rates by Province

[MoH Zambia]

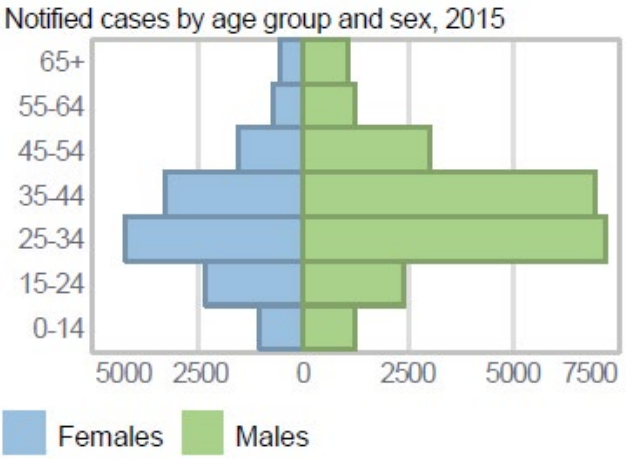


Treatment outcomes for smear-positive cases have steadily been improving (Figure 11.7)[11]. The treatment success rate was 85% for new and relapsed TB cases registered in 2013, 80% for previously treated cases and 27% for MDR-TB cases started on second-line regimen (Table 11.5)[10]. The regions with the highest number of cases (Copperbelt and Lusaka) also have good treatment success rates (Figure 11. 7)[12].

In contrast to national TB trends, the case notification rate for MDR-TB has been steadily increasing, from 18 cases in 2000 to 85 cases in 2011 (Figure 11.8)[13]. In high-risk places, such as prisons, rates of MDR-TB of up to 9,5% have been reported[14]. The estimated number of MDR-TB cases in 2014 was 610[15]. The treatment success rate for MDR-TB remains low with only 27% of cases having been successfully treated in 2014[16].

The national HIV prevalence rate in Zambia stands at 13,5% as of 2014[17]. There has been a steady drop in the HIV prevalence rate from 15,6% in 2001 to 2002[18]. The peak of HIV prevalence is among the 40-44 year age group[19].

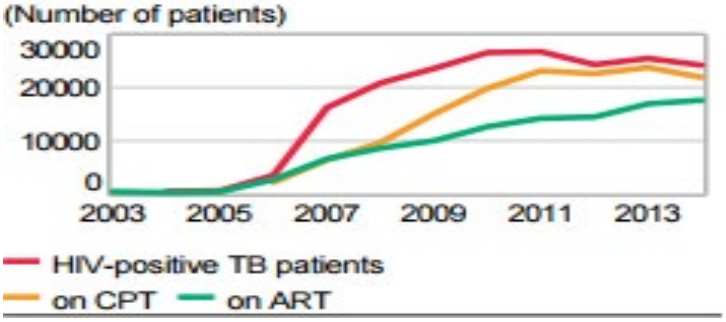
■ **Figure 11.5**
TB Case Notification by Sex and Age - 2015
[Source WHO



■ **Table 11.4 TB/HIV Co-infection** *[Source WHO]*

TB/HIV 2014	Number	(%)
TB patients with known status	39 763	(93)
HIV-positive TB patients	24 198	(61)
HIV-positive TB on co-trimoxazole preventive therapy (CPT)	21 929	(91)
HIV-positive TB patients on antiretroviral theraphy (ART)	17 611	(73)
HIV-positive people screened for TB		
HIV-positive people provided with IPT		

■ **Figure 11.6**
Number of patients
[MoH Zambia]



Females (16,1%) are more likely to be HIV positive than males (12,3%); HIV prevalence rates are higher in urban areas (20%) compared to rural areas (10%)[20]. The highest prevalence is reported in the Copperbelt Province (18,2%), followed by Lusaka Province (16,3%)[12]. Muchinga Province (6%) has the lowest estimated HIV prevalence rate[21].

Miners TB, HIV and Silicosis Data

TB is a significant problem in Zambian mines as reflected in the high TB rates of the Copperbelt province, which has the highest number of copper mines[22]. However, TB incidence rates in the mines mimic TB trends in the general population in that they have been steadily declining in the past 10 years[21,23]. The average weighted

Table 11.5 Treatment success rate *[Source WHO)]*

Treatment success rate and cohort size	(%)	Cohort
New and relapse cases registered in 2013	(85)	39 899
Previously treated cases, rxcluding relapse, registered in 2013	(80)	4 984
HIV-positive TB cases, all types, registered in 2013		
RR-/MDR-TB cases started on second-line treatment in 2012	(27)	100
XDR-TB cases started on second-line treatment 2012		

Figure 11.7
Treatment Success Rate 2009 -2012
[MoH Zambia]

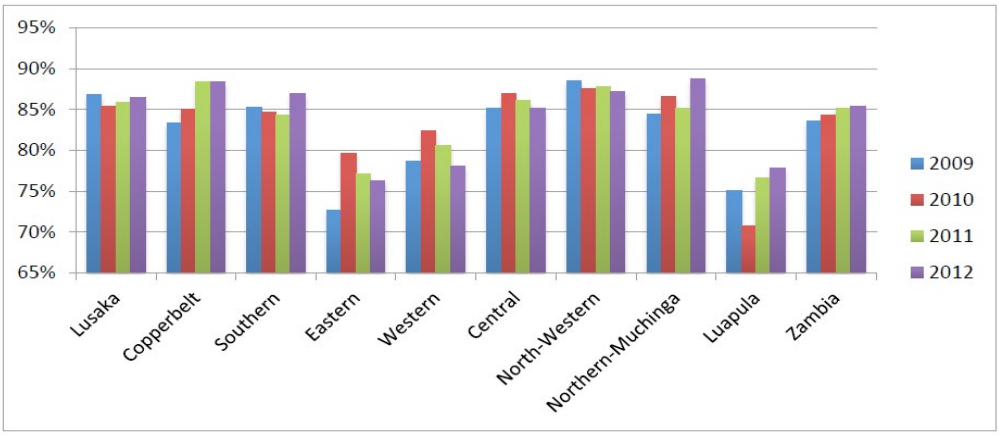


Figure 11.8
Number of MDR-TB Cases Diagnosed Per Year
[MoH Zambia]

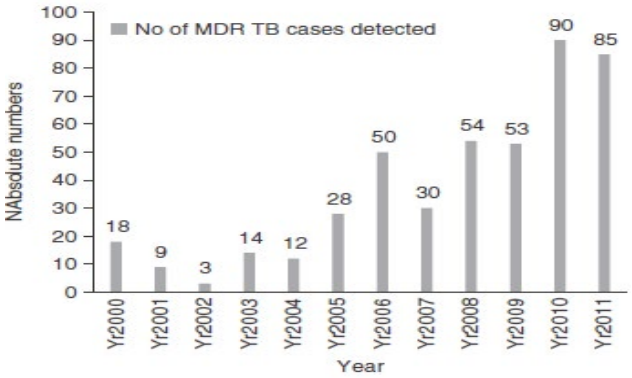
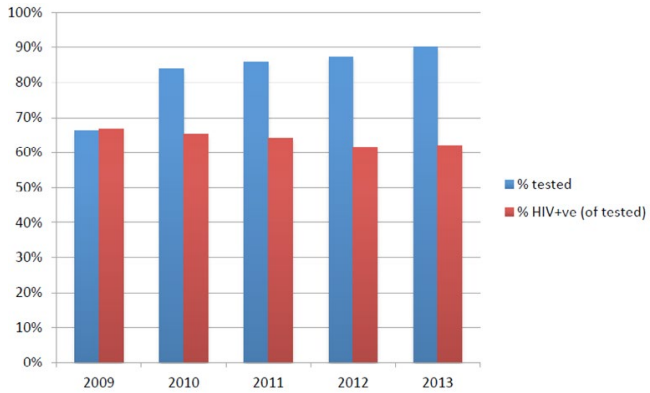


Figure 11.9
HIV testing in TB Patients 2009 – 2013
[MoH Zambia]



incidence rate of TB in current miners between 1994 and 2014 was 658/100 000 (Figure 11.10)[21]. Some mining districts such as Ndola, Kitwe and Solwezi have a TB prevalence that is up to 5 times (2 294 vs. 391 per 100 000) higher than the national prevalence[20]. Four of the top mining companies had a TB incidence of over 600 per 100 000 in 2013 (Figure 11.11)[20].

Silicosis and tuberculosis (TB) are significant mining-related illnesses in developing countries. Over the years, silicosis cases in miners have decreased, though there was a large increase in tuberculosis cases due to the increase of HIV. Miners workers diagnosed with silicosis have a higher risk of contracting TB. For example, in 2004 more than half (600 per 1 000) of the miners with silicosis had TB, whereas of those without silicosis, only 11 per 1 000 were diagnosed with TB (Table 11.6).

Published Literature

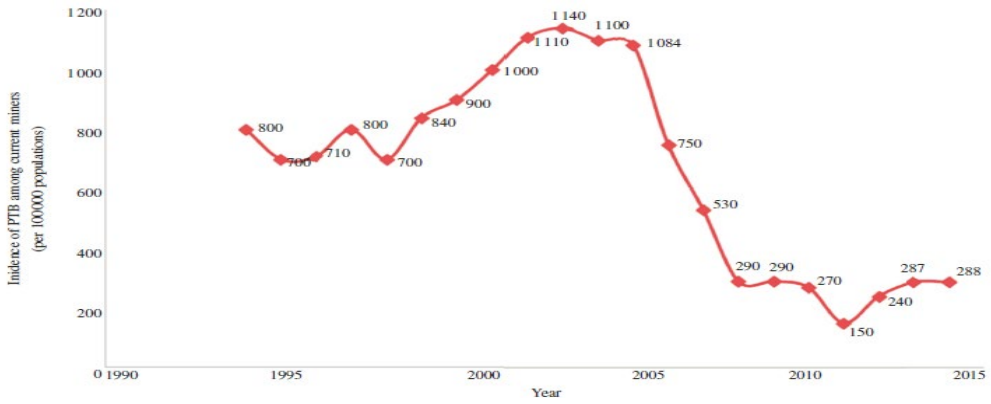
As part of the secondary data review, existing research publications for Zambia have been summarised. Few publications focussed on miners and mine health in Zambia. Most publications found were based on research conducted on miners and mining communities in and around copper mines.

1. *Siziya et al.* (2013) published results of exposure to occupational health hazards among Zambian workers[21]. The results of the study showed that Zambian workers are exposed to a broad range of occupational health hazards such as vibration from hand tools; fumes, smoke and dust inhalation, as well as heavy object lifting, among others[21].

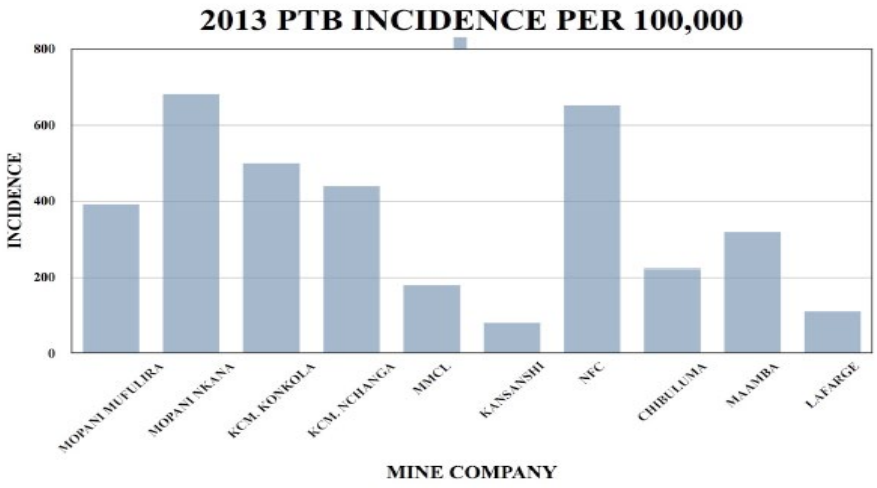
2. *Laima et al.* (2012) published prevalence and correlates of lung-function impairment among miners[22]. In this study 3,3% of participants had severe impairment, 4,1% moderate, 19,7% mild and 73% had normal lung function. Morning cough and chest tightness were significantly associated with abnormal lung function tests[22].

3. *Hayumbu et al.* (2008) published a paper on silica exposure measurements at two Zambian Copper mines, Nkana and Mufulira[23]. The study found that 26% of

■ **Figure 11.9**
Trends of PTB Incidence among Current Copper Miners
[Siziya et al 2005]



■ **Figure 11.10**
TB Incidence per Mining Company
[Mulunga et al 2005]



Nkana and 59% of Mufulira mine samples were above the recommended dust exposure levels. Weak dust monitoring regulations may result in many miners being exposed to high dust levels[23].

4. *Mulenga et al.* (2005) published a paper on silicosis and TB among Zambian miners, comparing two time periods: before the arrival of the HIV epidemic (1960-1970) and after the arrival of the HIV epidemic (1992-2002)[20]. The study found that there were 2 114 cases of occupational lung diseases from 1945 to 2002. Of these cases, 22,7% were silicosis, 65,4% TB, and the remaining 11,9% silicotuberculosis. The study also found that silicosis cases decreased from 28,6% to 12,4% with the arrival of HIV but TB cases increased (from 37,1% to 86,1%). Although silicosis remains an occupational health issue in Zambian miners, the most significant problem appears to be the marked increase in cases of TB[20].

Perceptions of key informants

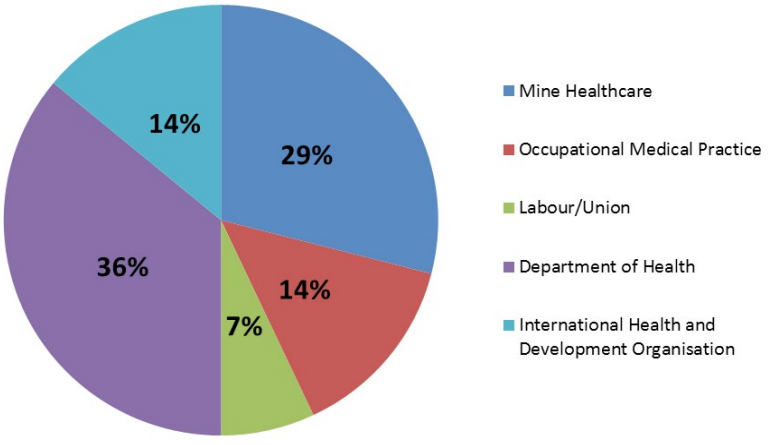
Demographic analysis

A total of 14 participants were interviewed in Zambia, of which ten were from the Copperbelt and four from Lusaka provinces. The informants represented various sectors with most informants representing Mine Healthcare (29%: 4/14) and Department of Health (36: 5/14) (Figure 11.12). Most informants were trained in the healthcare sector (medical doctors, nurses) and had been in their current roles for a median of six (IQR: 4-13) years. The median age of the informants was 44 (IQR: 35-57) years. Most informants interviewed had a good grasp of the mining landscape as well as the prevailing health issues affecting miners in the country. The common theme of the interviews was that health services available to miners differed from those ex-miners and mining communities accessed.

Table 11.6 Rates of PTB in silicotics and non-silicotics *[Zambia Copperbelt NOHI]*

Year	Silicotics per 1,000 population	Non-Silicosis per 1,000 population
2000	212	9
2001	77	10
2002	130	11,1
2003	384	11,4
2004	600	11

Figure 11.11
Population Description
[Sectors of Key Informants]



Mining

Informants highlighted that quarrying, underground and surface mining methods are still active. Some of the most commonly mined commodities mentioned include: copper, cobalt and coal (Figure 11.13). The big Zambian mining companies as reported by the informants are: Konkola copper mine (KCM), First Quantum, Mopani copper mine, Barrick Gold mine and Kansashi copper mine. Most mining companies were reported to be in the Copperbelt Province.

Health Services in Zambia

Informants reported that health services in Zambia are adequate for miners, as most mines have hospitals or clinics. Current miners receive free health services at the mine hospitals while ex-miners are given free health services for up to five years from the day of retirement. Once this period has elapsed, ex-miners would then have to access free care from government services or pay for the continued use of mine healthcare services.

"When they are coughing they go to the plant site clinic, the nurse will assess and referrals is done when they see if this situation is serious."

(KI066, Department of Health).

In addition, some mine hospitals and clinics provide health services to the peri-mining communities. However, community members are regarded as private patients and have to pay for services.

Health and Legislation

Informants noted that Zambia has legislation on mine health and safety, and this can be accessed on the Internet. Most mining companies do adhere to the legislation and employ health and safety representatives to promote compliance with legislation. This legislation, however, is not regularly reviewed. Miners diagnosed with TB and/or silicosis can get compensation but many regard the money as insufficient. The process of applying for and receiving compensation is complicated as it may require numerous consultations and frequent travel, which is costly. Informants also indicated that some miners have little information about their compensation entitlements. Therefore, most miners do not claim for compensation.

"Miner has to be certified by OHSI and then referred to workers' compensation for claim, however, compensation given is too small."

(KI001, International health and development organization)

Legislation in Zambia stipulates that miners who contract TB should be certified unfit for work. Consequently, many miners fail to seek healthcare when they are ill for fear of having their employment terminated.

"Yes but most cannot return to work as TB is classified as an occupational disease so they can no longer work in specified areas in the mine."

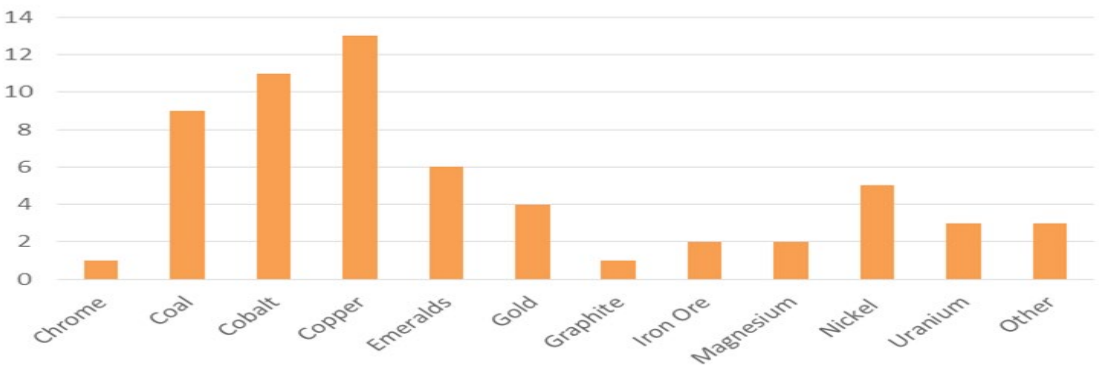
(KI001, International Health and Development Organization).

For certain health conditions, miners can receive paid sick leave for a limited period (90 days a year).

Figure 11.12

Key informants' knowledge of mined commodities

[Interviews]



TB Prevalence

TB prevalence among miners is perceived to be high when compared to the general population. TB health services (screening, prevention and treatment) are offered to current miners through mine and state health facilities. TB services are offered to mining communities mainly from the government or NGOs and in some cases mine healthcare centers. Some informants mentioned that the public health sector conducts TB contact tracing for the family members of diagnosed miner.

"If living with the miner may go to either mine health facility if available or public health facility"

(KI001, International Health)

The adherence for TB medication among miners is reported to be relatively good, depending on where they get treatment. One participant noted:

"If the medication is through the mine hospitals, adherence is good but some miners prefer non-mine facilities so that the mines are not aware of their TB status for fear of losing employment"

(KI004, department of health).

The overall perception on MDR-TB is that it is low and that adherence to treatment is relatively good. However, obstacles to adherence mentioned were stigma and loss of employment, unavailability of MDR-TB drugs and the length of treatment, as well as migration). Informants indicated that miners have access to MDR-TB screening and treatment mainly through government hospitals.

HIV

Informants perceived miners, ex-miners and their communities to have a higher HIV prevalence. However, some mentioned that HIV prevalence is slowly declining among miners.

"The rate has been falling it is now 12,5%"

(KI057, Mining Industry or Healthcare).

The perception among informants is that the country has improved on HIV services and that adherence to HIV treatment is good. The HIV services available to current miners include HIV prevention such as male medical circumcision (MMC).

Silicosis

Informants stated that silicosis is not a major health problem in Zambian miners. Miners are not extensively exposed to silica dust as more copper mining than gold mining takes place in the country. However, it was noted that no studies have been done looking specifically into silicosis in Zambia. The only available health facility in the country to diagnose silicosis was reported to be the National Occupational Health Institute (NOHI) in Kitwe, Copperbelt.

"The available data is biased because it depends on those who present themselves for medical surveillance who in most cases come when they have some chest problems."

(KI004, Occupational Medical Practice)

"Not much info on subject. NOHSI conducts regular screening of mine workers but not all covered."

(KI001, International Health and Development)

Summary of key findings

- Zambia is a High-TB Burden country with a TB prevalence of 436/100 000
- TB prevalence in the mines is even higher than in the general population, with rates above 600/100 000 reported in some mines.
- TB prevalence is highest in the Provinces of Lusaka and Copperbelt, which are urban mining areas.
- The TB/HIV co-infection rate is high, with a prevalence of 61%.
- The rate of MDR-TB is increasing, with 610 cases reported in 2014.
- The national HIV prevalence rate is 13,5% with the highest prevalence rates reported in Lusaka and Copperbelt.
- Miners have adequate health care services for TB screening and treatment.
- The fear of job loss negatively affects miners' health-seeking behaviour.
- By law, miners must receive compensation for occupational lung diseases, but they have little knowledge about this compensation.

Data gaps and limitations

This report is limited by gaps in the available data. Up-to-date statistics on TB, MDR-TB and HIV, disaggregated at a provincial and district level, are limited. Little published data focuses on miners and mining in Zambia. The health records of miners and ex-miners available from The Occupational Health and Safety Institute (OHSI) are inadequate, due to some miners not presenting for annual health certification assessments. As a result, an accurate picture of the levels of occupational lung diseases among miners cannot be drawn. There are no mechanisms to trace migrant mine workers employed outside of Zambia. Our review of secondary data found no information on artisanal and small-scale mining in Zambia.

Conclusion

In a healthy workplace, health risks are recognized and controlled if they cannot be removed. A safe workplace is an environment where the workers' well-being (physical, mental and social) is promoted and maintained. All possible efforts should be made to prevent workers' ill health caused by a hazardous working environment. The opening of copper mines in Zambia created various work-related problems. In response to such problems the Factories Act or CAP 514 was established[17]. Silicosis and TB remain an occupational health issue in Zambian miners and more regulations should be geared towards protecting them in the workplace.

Recommendations

- Make the Lusaka and the Copperbelt Pprovinces the priority areas for health services and interventions for miners.
- Integrate TB and HIV care in peri-mining communities.
- Increase uptake of TB prophylaxis among HIV infected people.
- Implement more frequent TB drug resistance surveys.
- In conjunction with the Ministries of Health, expand facilities with the capacity to diagnose and manage MDR-TB.
- Conduct more research in mines and mining communities to determine the burden of occupational lung diseases.
- Strengthen the current occupational health institutions in the country to improve their capacity to implement effective surveillance of miners and ex-miners.
- Educate miners about the occupational compensation benefits available to them.
- Review legislation that allows for miners to lose their jobs when diagnosed with occupational lung diseases.

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Small-scale and artisanal miners contribute 30% of the gold produced in the country. Most of the illegal small-scale miners are predominantly gold diggers and panners, and are based along the major rivers.

Chapter 12: **Zimbabwe**

Executive Summary

Background: Zimbabwe is a landlocked country, bordered by Botswana, Zambia, and South Africa, with an estimated population of 13-million. More than half (67%) its people are based in rural areas. The country is divided into 10 provinces and 63 health districts. Zimbabwe has been in a state of economic crisis since 2000, with 60% unemployment, negative economic growth and recurrent food crises. The economic crisis has hit the healthcare system, resulting in shortages of healthcare workers and medical supplies as well as mainstay industries including mining, agriculture and tourism. Mining is concentrated along the Great Dyke area, which spans 550km, as well as diamond deposits to the east of the country. Commodities mined include nickel, copper, cobalt, gold and platinum. An estimated 45 000 miners were employed in the formal sector in 2012, down from 59 000 in 1995 as some mines closed. The artisanal and small-scale mining industry is expanding, employing between 300 000 to 400 000 miners.

Key Findings: The HIV prevalence rate among adults is 15,2%. Some districts (Matebeleland, Bulawayo) along the Great Dyke have a higher HIV prevalence compared to the national average. The TB incidence is 603/100 000, with the TB epidemic in Zimbabwe largely driven by the HIV epidemic, evident by a TB/HIV co-infection rate of 68% in 2013. The government established a pneumoconiosis surveillance program, which between 2010 and 2015 screened 112 032 mineworkers between 2010 and 2015, and diagnosed 115 cases of pneumoconiosis, giving a prevalence of 0,1%.

Limitations: The main data challenges are the vast mining territory, high number of undocumented and unregulated artisanal and small-scale miners, and few publications on mineworker's health in Zimbabwe. There is a paucity of primary data on TB among miners. Also, we were unable to get ethical clearance for interviews and were unable to carry out stakeholder interviews.

Recommendations: Epidemiological studies among miners and their communities, including informal miners will inform the location of OHS centres in the country.

■ Figure 12.1
Map of Zimbabwe

Introduction

Zimbabwe is a low-income country in Southern Africa bordered, by Zambia to the north, Mozambique to the east, Botswana to the west and South Africa to the south. Zimbabwe has a population of approximately 13-million people, 48% of whom are male and most of whom (67%) live in rural areas[1]. Zimbabwe has 16 official languages with English, Shona, and Ndebele the most commonly used[2]. The country is divided into 10 Provinces and 63 health districts. Harare is the administrative capital and Bulawayo serves as the second capital city[3].

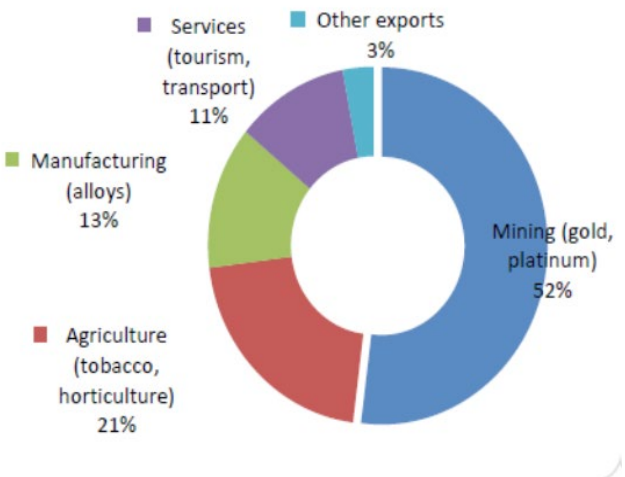
Since early 2000, the country has experienced economic and political crisis, characterised by negative economic growth, a high unemployment rate of more than 60%, as well as a recurrent food crises[4]. The low national income has resulted in reduced funding to health care and public health[5].

Mining, agriculture and tourism are the mainstays of the Zimbabwean economy and in 2014, over half (52%) of export revenue came from mining (52%), agriculture (21%) and tourism (11%) (Figure 12.2)[5]. Mining and agriculture are linked to 80% of current infrastructure, development and growth of the towns and cities in Zimbabwe. Mining contributes 5,4% to the country's GDP[6].

General health indicators

Health-care in Zimbabwe is provided by public facilities, non-profit groups, church organizations, company-operated clinics (such as those of mining companies), and for-profit clinics[7]. The political, economic and social difficulties have severely affected the healthcare system in the country, resulting in shortages of healthcare workers[7]. Decreased funding to the healthcare system has reduced

■ **Figure 12.2**
Distribution of Exports in 2014
[Chamber of Mines Zimbabwe]



■ **Table 12.1 Health care facilities by type in Zimbabwe** *[Osika et al, 2011]*

Type of Facility	Number of Facilities
Central hospital	6
Provincial hospital	7
District hospital	46
Mission hospitals designated as district hospitals	6
Rural Clinics/Hospitals	1 118
Mission Clinics/Hospitals	86
Company Clinics/Hospitals	43
Private Clinics and Hospitals	93
Military Clinics	2
Prison hospitals	2
Other health facilities	17

the system's capacity to purchase medical supplies, stocks of essential drugs and vaccines, and to pay healthcare workers properly[7]. A shortage of skilled healthcare workers limits the ability to provide health services, especially as demand has increased due to HIV[7].

Zimbabwe's life expectancy at birth is 60 years[8]. Zimbabwe is on track to achieving its HIV and malaria targets in Millennium Development Goal 6 but it will not be able to meet goals related to maternal and child health[9]. Although child mortality in general has decreased, it is still high with mortality of 69/100 000 in children under five years, 50/100 000 in infants, and 29/100 000 in newborns. The primary causes of death in Zimbabwe are: HIV, lower respiratory infections, diarrhoeal disease and Tuberculosis (Figure 12.3)[8].

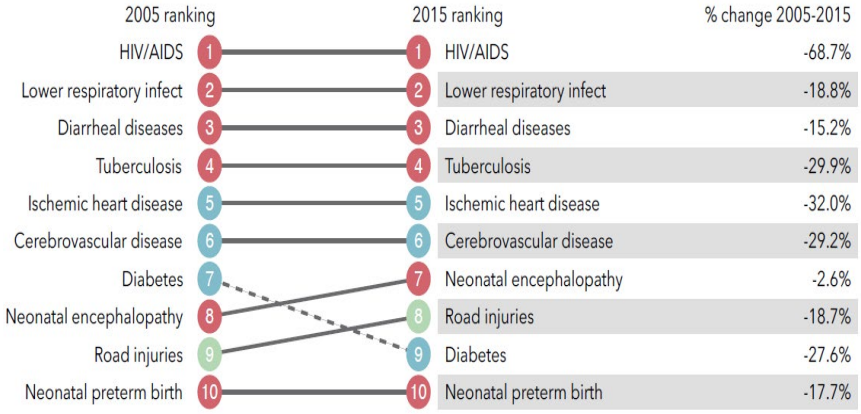
Mining landscape

The mining industry is characterised by formal large scale mines and artisanal and small-scale mines (ASM). There are 1 300 registered mines in Zimbabwe. Zimbabwe exports most (90%) of its mined commodities[6]. Mining is concentrated along the Great Dyke, also known as the "mineral hub" of the country. The Dyke spans 550km, varying in width between 2km and 11km (Figure 12.4)[9]. Large deposits of nickel, copper, cobalt, gold and platinum are mined along the Dyke. Zimbabwe has the second largest platinum reserve after South Africa and most of the reserves are found along the Great Dyke.[10] The most commonly mined commodity in Zimbabwe is gold, which accounts for 40% of the total mineral output by value. The gold mining industry employs about half

■ **Figure 12.3**

Major causes of death in Zimbabwe, 2005 and 2015

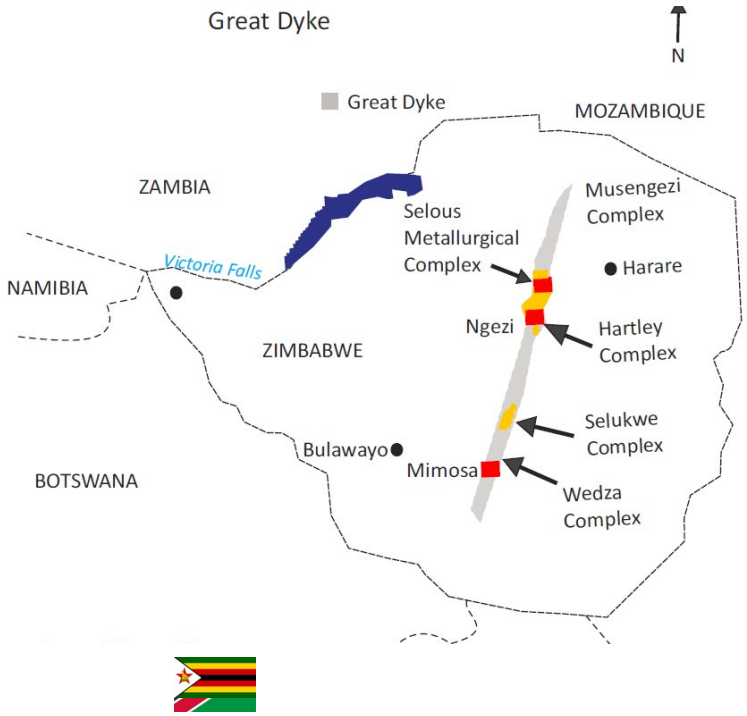
[Source: www.healthdata.org]



■ **Figure 12.4**

Map of the Great Dyke in Zimbabwe

[www.implants.org]

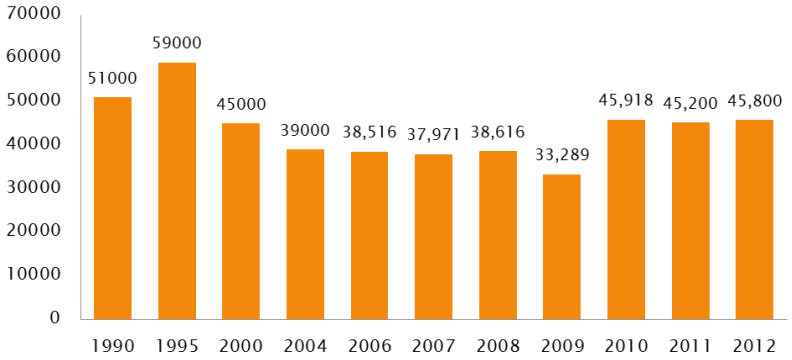


of the mining industry's total labour force[6]. In addition, diamond deposits were discovered to the east of the country as well as coal deposits in the Hwange area. As a result, mining activities are found across multiple provinces and districts[9].

The mining sector formally employs just under 46 000 miners[11], fewer than the peak in 1995 of 59 000 (Figure 12.5). Reasons for decreasing numbers include retrenchments and closures of some mines[10].

In addition, it is estimated that there are between 300 000 and 400 000 small-scale and illegal miners who support over two-million people[12]. These miners, commonly referred to as "*makorokoza*" are difficult to document[12]. Small-scale and artisanal miners contribute 30% of the gold produced in the country[13]. Most of the illegal small-scale miners are predominantly gold diggers and panners, and are based along the major rivers[6]. ASM miners face limited access to credit finance, restrictive market conditions and no healthcare services infrastructure. Health and safety

■ **Figure 12.5**
Formally employed in the mining sector[10]
[Makore G et al, 2012]



■ **Table 12.2 HIV epidemic indicators**

	2010	2013
People living with HIV	1 300 000 (1 300 000-1 400 000)	1 4000 000 (1 3000 000 -1 4000 000
New HIV Infections	91 000 (83 000 -97 000)	69 000 (61 00 -78 000)
Adult 15+ new HIV infections	71 000 (65 000 -77 000)	60 000 (53000 -68 000)
AIDS-related deaths	81 000 (76 000 -85 000)	64000 (59 000 -68 000)
HIV prevalence (adults aged 15-49)	16,0% (15,3 -16,8%)	15,0 (14,2 -15,7%)
HIV Incidence (adults aged 15-49)	1,3% (1,18 -1,42%)	0,98% (0,86 -1,11%)
Children (0-14 Years) living with HIV	200 000 (180 000 -220 000)	170 000 (150 000-190 000)
Children (0-14 Years) newly infected with HIV	20 000(17 000 -22000)	9 000 (6200 - 12 000)
Adult 15+ living with HIV	1 100 000 (1100 000 -1200 000)	1200 000 (1200 000 -1300 000)
Women 15+ living with HIV	670 000 (640 000 -700 000)	720 000 (690 000 -750 000)
HIV prevalence among young women (15-24 years)	7,0% (6,3 -8,4%)	6,6% (5,9- 7,9%)
HVI prevalence among young men (15-24 years)	4,1% (2,9-5,8%)	4,1%(3,1-5,6%)
Now HIV infections among young women (15-24 years)	19 000 (17 000- 21 000)	15 000 (13 000- 17 000)
New HIV Infections among young men (15-24 years)	11 000(8 700- 13 000)	8 600(6600 - 11000)
HIV positive incident 18 cases	83 000 (64 000- 100 000)	77 000(60 000- 70 000)
Percentage of Men Circumcised (Adult 15049 years)	11%	11,5%

Sources: UNAIDS 2013 HIV estimates - WHO Global TB Report 2013; Global Aids Response Progress Report (DARPR) 2013

in ASM mining is poor, with an estimated 20 people killed annually. Since the Department of Mines and the Chamber of Mines do not recognise these deaths as mine fatalities, because some ASM mines are considered illegal operations, the number of fatalities could be under reported and outdated[6].

Results

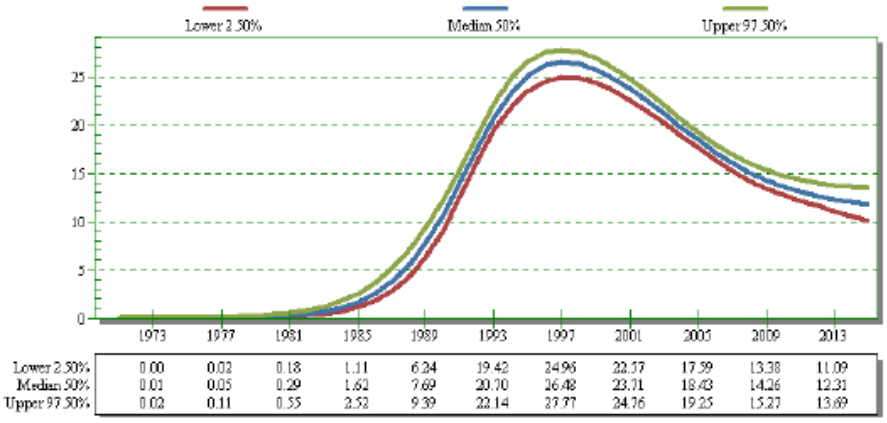
General Population TB and HIV Epidemiology Data

HIV in Zimbabwe remains a major public health concern. The population HIV prevalence rate among adults is 15,2%, down from over 25% in the late 90s, (Figure 12.6)[14]. Around 1,4-million people are living with HIV in Zimbabwe and in 2013 there were 69 000 new HIV infections[14]. The HIV prevalence rate among young men (aged 15-24) is 4,1% compared to 6,6% in women of the same age group (Table 12.2)[14]. The number of new HIV infections in the age group 0-14 years has decreased from 20 000 in 2010 to 9 000 in 2013, most likely due to improvements in the Prevention of Mother to Child Transmission (PMTCT) programme[15]. Matabeleland South province has the highest prevalence of HIV (21%), (Figure 12.7)[15].

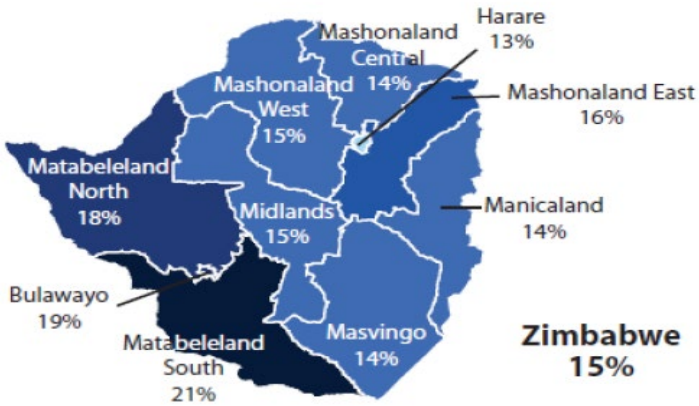
The TB epidemic in Zimbabwe is largely driven by the HIV epidemic and follows the same trend with a 10-year shift (Figure 12.6). The TB incidence in the country is 278/100 000 (Figure 12.8) with 32 000 cases reported in 2013[16]. Among these TB cases, 8% were aged below 15 years and the male to female ratio is 1:3[16]. Provider-initiated testing and counselling of HIV for all confirmed TB patients is part of the national TB control programme policy. Thus, in 2013, 89% of TB patients were tested for HIV and 68% were co-infected with TB/HIV, and of these 86% were accessing ART[16]. In the new TB cases, MDR-TB prevalence is 3% while it is 6% in the retreatment TB cases[16].

In a report presented by the by the Ministry of Health, at workshop on occupational health services in Zimbabwe, it was stated that a pneumoconiosis surveillance program was started in 2010. Since its inception, a total of 112 032

■ **Figure 12.6**
Prevalence Adult for HIV
[MoH Zimbabwe, 2013]



■ **Figure 12.7**
HIV epidemic indicators
[MoH Zimbabwe, 2013]



applications were done, with varying numbers per year, increasing from 11 093 in 2010 to 21 097 in 2015. The overall pneumoconiosis prevalence was 0,1% (Table 12.3)[17]. The highest number (33) of pneumoconiosis cases was diagnosed in 2015.

Published literature

There is little published data on HIV/AIDS, TB and silicosis among miners and ex-miners in Zimbabwe. One publication looked at pneumoconiosis among coal and heavy metal miners. Pneumoconiosis was more prevalent in coal miners, followed by copper (5,7%), gold (4,8%) and nickel (4,5%) (Table 12.4)[18].

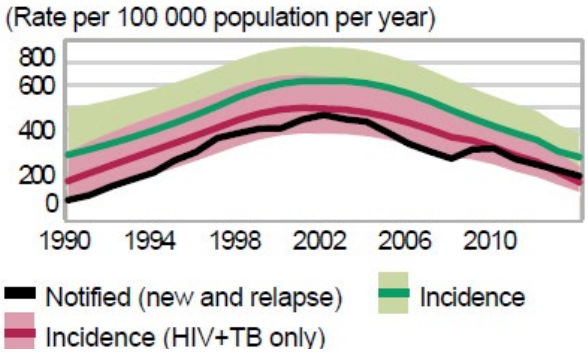
Summary of Key Findings

- The mining area in Zimbabwe spans multiple districts and provinces.
- The economic crisis has hit the country's health system hard, causing shortages in personnel, medical supplies and equipment.
- Zimbabwe has both artisanal and small-scale, and formal large-scale mining sectors. Formal mining employed 45 800 miners in total in 2012, while the ASM sector was estimated to have 300 000-400 000 employees.
- ASM contributed 30% of the gold produced in the country. The ASM sector has high fatality rates (20 deaths a year), and poor compliance with health and safety regulations.

■ **Figure 12.8**

TB incidence in Zimbabwe

[WHO TB Report]



■ **Table 12.3 Summary of pneumoconiosis cases diagnosed per year from 2010 to 2015**

[Source: Ministry of Health of Zimbabwe]

	2010	2011	2012	2013	2014	2015
Pneumoconiosis fitness applications	11 093	25 010	16 216	18 347	20 269	21 097
Pneumoconiosis applications processed	11 662	21 769	19 797	16 933	18 242	18 153
Fitness certificates issued	10 179	19 302	16 482	13 025	14 895	18 064
Pneumoconiosis cases diagnosed	14	18	12	29	9	33
Pneumoconiosis Prevalence	0,1%	0,1%	0,1%	0,1%	0,0%	0,2%

■ **Table 12.4 Published Data on HIV/AIDS, TB and Silicosis amongst miners in Zimbabwe**

Reference	Methodology	Results
Cullen MR and Baloyi RS. Prevalence of pneumoconiosis among coal and heavy metal miners in Zimbabwe. American Journal of Industrial Medicine, 17:677-682, 1990.	Cross-sectional study among coal, nickel, copper and gold miners in multiple districts to assess the prevalence of pneumoconiosis.	Overall presence of abnormalities on X-rays were 10,4% in coal miners, 4,5% in nickel miners, 5,7% in copper miners and 4,8% in gold miners.

- The overall HIV prevalence in adults is 15,2%, which has dropped from 25% in the 1990s.
- Women are disproportionately affected, having higher prevalence rates compared to men across many age categories.
- Matabeleland province has the highest HIV prevalence of 21%.
- The TB incidence in the country is 278/100 000 and females are also more affected. The HIV/TB co-infection is 68%.
- Based on the national Pneumoconiosis Survey, overall pneumoconiosis prevalence is 0,1% in mine workers.
- There is little published data on HIV/AIDS in mine workers in Zimbabwe. One article indicated that pneumoconiosis prevalence was 4,5%-10,5% in mine workers and varies by commodity mined.

Data Gaps and Limitations

There are gaps in information about informal mining, and more studies are needed. Little information exists on miners and occupational diseases.

Conclusion

Zimbabwe is a low-income country that is grappling with political, social and economic crises that directly affect the healthcare system. The HIV prevalence in the country has decreased but is still high, with women disproportionally affected. The TB epidemic in Zimbabwe is largely driven by the HIV epidemic. Silicosis in Zimbabwe is predominant amongst coal, nickel and gold miners. There is not much published data on HIV, TB and silicosis among miners in Zimbabwe.

Recommendations

Undertake more epidemiological studies of silicosis in formal miners, and artisanal and small-scale and illegal miners.

- Do more studies on mines and occupational diseases such as TB, HIV and injuries.
- Do more research to document artisanal and small-scale miners.

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"Results showed a significant dose response relationship between death from lung cancer and silica dust particle-years and cigarette equivalent pack-years."

Hnizdoet al.

Annexure 1: Published Literature – South Africa

REFERENCE	METHODOLOGY	RESULTS	COMMENTS
1. Corbett et al. Stable Incidence Rates of Tuberculosis (TB) among Human Immunodeficiency Virus (HIV)–Negative South African Gold Miners during a Decade of Epidemic HIV-Associated TB, 2003:188(15 October)The Journal of Infectious Diseases 2003; 188:1156–63	Combined data from 3 cohorts of gold miners over 3 time periods.	HIV Prevalence 1993: 4,3% 19996: 7,7% 1999: 24.0% TB Incidence/ 100 000 PYs: 18–29: 245 30–34: 584 35–39: 1 494 40–44: 1 071 45–49: 1 651 50: 3 435 Silicosis/ 100 000 PYs: None: 853 Possible: 1 402 Probable: 1 635 Early: 2 098 Moderate to Advanced: 3 985	Incidence rates of TB in HIV-negative individuals are highly dependent on background TB transmission rates. The combination of an intensive TB control program and the rapid progression and lower per-case infectivity of HIV-associated TB appears to have succeeded in maintaining static TB transmission rates, despite the failure to control incidence rates of TB. Good TB control programs may still be able to maintain stable incidence rates of TB among HIV-negative individuals living in populations with high prevalence of HIV.
2. Zuma Ket al. Risk factors for HIV infection among women in Carletonville South Africa: migration, demography and sexually transmitted diseases. Int J STD AIDS. 2003 Dec;14(12):814-7	Community-based cross-sectional survey of women in a peri-mining community of Carletonville.	HIV Prevalence: 13–2: 35,7% 26–35: 50,9% 36+: 24,8%	HIV infection was higher among migrant women.
3. Kemsley DM (Doctoral dissertation). Respirable dust and quartz exposure of Rock Drill Operators in two Free State Gold mines, 2000. A research report to the Faculty of Health Sciences, University of the Witwatersrand, in fulfilment of the requirements for the degree of Master of Public Health, Occupational Hygiene	Descriptive, cross-sectional, rapid assessment based on the findings of gravimetric sampling results taken at Rock Drill Operators working underground in a gold mine		Rock drill operators are potentially exposed to high levels of harmful dust and quartz in their normal daily work if not adequately protected using good, effective appropriate and comfortable respiratory protective equipment (RPE) and additionally having proper ventilating velocity.
4. Glynn et al Effects of duration of HIV infection and secondary tuberculosis transmission on tuberculosis incidence in the South African gold mines. AIDS (London, England) 22(14):1859-67 · 2003	Survival analyses of overall rates of TB on the mines from 1991 to 2004	HIV Incidence: 1,3% in 1990, rising to 20–30% by 1998	Tuberculosis incidence rose soon after HIV infection, reaching 1,4/100 person- years (95% confidence interval 1,1–1,9) within 2 years, and 10,0/100 person-years (95% confidence interval 6,5–15,5) at 10 or more years. By 11 years from seroconversion, nearly half the men had had tuberculosis. Among 5 702 HIV-negative men, tuberculosis incidence was 0,48/100 person-years (95% confidence interval 0,33–0,70) in 1991–1993 and doubled over the period of the study
5. Lurie et al, The impact of migration on HIV-1 transmission in South Africa. A study of Migrant and non-Migrant Men and their partners. Sexually Transmitted Diseases, Vol. 30 No. 2003	A cross-sectional study of migrant men and their rural partners, as well as non-migrant men and rural women whose partners are non-migrant.	HIV Prevalence Migrant Males: 22–34: 33,8 % 35–49: 21.2% 50–66: 17,7% HIV Prevalence of Female Partners of migrants: 22–34: 25,7% 35–49: 15,1% 50–66: 20%	Migration is an independent risk factor for HIV infection among men. High rates of HIV were found among rural women, and the migration status of the regular partner was not a major risk factor for HIV. Rural women lack access to appropriate prevention interventions.
6. Mallory et al, The impact of HIV infection on recurrence of tuberculosis in South African gold miners Int J Tuberc Lung Dis. 2000 May;4(5):455-62.	Retrospective cohort analysis of 305 HIV positive and 984 HIV-negative South African gold miners treated for TB with directly observed, rifampicin-based regimens since 1990. They were followed-up until a diagnosis of recurrent TB.	HIV Prevalence: 24% TB Prevalence: HIV-positive = 71% HIV-negative = 75% Silicosis Prevalence Intermediate HIV-positive: 16% HIV-negative: 18% Early to advanced HIV-positive: 9% HIV-negative: 16%	HIV infection results in an increased risk of recurrence following treatment of TB in miners, despite the use of directly observed therapy and rifampicin-based regimens.

7. Lewis et al, Eligibility for Isoniazid Preventive Therapy in South African Gold Mines PLoS ONE 8(11): e81376. doi:10.1371/journal.pone.0081376 2013	Cross-sectional survey of gold miners		Majority of individuals assessed were eligible for IPT.
8. Trapido AS (Doctoral dissertation). Occupational respiratory diseases in the South African mining industry, Glob Health Action 2013.	Community-based cross-sectional survey of ex-miners in the Eastern Cape.		High rates of lung diseases due to exposure to high concentrations of dust in gold mines. Statutory regulations inadequate to protect workers. There is a need to evaluate current dust-control methods. All former mineworkers need access to post employment medical benefit examinations and autopsy at death.
9. 1999 Churchyard et al. Mycobacterial disease in South African gold miners in the era of HIV infection Int J Tuberc Lung Dis. 1999 Sep;3(9):791-8. PubMed PMID: 10488887.	Retrospective record review of a database of miners at a gold mine from 1990 to 1996. To investigate the impact of HIV on tuberculosis case rates and case detection method	HIV Prevalence: 20–29: 47% 30–39: 33,1% 40–49: 27.2% 50–59: 22,6% TB Incidence: 1990: 1 176/100 000 per year 1996: 2 476/100 000 per year	Rising incidence of TB in South African gold miners due to a high prevalence of HIV and silicosis. Reducing silica dust exposure and HIV transmission needs to be included as part of a comprehensive strategy aiming to reduce TB incidence in the mining industry.
10. 2002 Corbett et al. Morbidity and Mortality in South African Gold Miners: Impact of Untreated Disease Due to Human Immunodeficiency Virus The Infectious Diseases Society of America. All rights reserved. 1058-4838/2002/3409	Prospective cohort of miners who tested for HIV at a Gold mine and followed up from February 1998 to February 1999.	HIV Prevalence: 24%	HIV infection greatly increased rates of hospitalization and death because of significantly increased rates of a range of different infectious diseases. TB was the single most common cause of hospitalization for the HIV-positive cohort.
11. Dharmadhikari et al, Aspiring to zero tuberculosis deaths among Southern Africa's miners: is there a way forward? Int J Health Serv. 2013;43(4):651-64.	Commentary	HIV Prevalence: 25%-30%	4-7 000/100 000 TB notification rate among miners
12. Roberts, J. The hidden epidemic among former miners: Silicosis, Tuberculosis and the Occupational Diseases in Mines and works Act in Eastern Cape, South Africa, Health Systems Trust 2009	Cross-sectional surveys among former underground gold miners in the labour-sending areas of the Eastern Cape.	TB Prevalence: 12,21%	Knowledge of the ODMWA found to be non-existent. Extremely high rates of TB and other respiratory illness amongst the former miners. Most miners did not receive exit medical exams. Need for improvement in medical surveillance, and compensation for occupational disease. Need for immediate training on the ODMWA for all Health Personnel.
13. Ehrlich et al. Tuberculosis and silica exposure in South African gold miners. Occup Environ Med. 2006	Cross-sectional study of gold miners	TB prevalence: 35%	Older in-service gold miners in South Africa have a high prevalence of PTB, which is significantly associated with dust and silica exposure, even in the absence of silicosis. There is a need for increased tuberculosis surveillance in groups exposed to higher dust and silica levels on the mines. Need for improved dust and quartz control in mines.
14. Day et al. Screening for tuberculosis prior to isoniazid preventive therapy among HIV-infected gold miners in South Africa. The International Journal of Tuberculosis and Lung Disease, Volume 10, 2006	Cross-sectional study of HIV-infected employees attending a preventive therapy clinic between to compare screening tests for TB.	TB prevalence: 4,9%	Chest X-rays (CXR) greatly increased the sensitivity of screening for TB. Sputum microscopy conferred no additional benefit among asymptomatic patients with a normal CXR. Active screening for TB should be done in persons with low CD4 count.
15. Cowie et al. Association of silicosis, lung dysfunction, and emphysema in gold miners. Thorax 1993;48:746-749 doi:10.1136/thx.48.7.746	A sample of 70 men from a cohort of older gold miners with and without silicosis to determine prevalence of respiratory disease.		Results showed an association between silicosis and emphysema in that the lung dysfunction associated with silicosis seems to be caused by the associated emphysema. Silicosis is a marker, visible on conventional radiography, for emphysema and for lung dysfunction.

16. Kleinschmidt et al. Variation in incidences of tuberculosis in subgroups of South African gold miners. Occup Environ Med 54 (9), 636-641. 9 1997	A retrospective cohort analysis of gold miners to determine risk factors and to identify groups at high risk of tuberculosis.	HIV Prevalence: 15-24: 19% 25-34: 17% 35-44: 12% 45-54: 9% 55-64: 10% TB Incidence: HIV- positive: 16/1 000 PY's All miners: 8,2 /1 000 PY's Silicosis Incidence: 26,39/1 000 PY's	Profile of mineworkers who are at high risk of TB can be defined by age, mining occupation, silicosis status, and HIV infection.
17. Hnizdo et al. Risk of pulmonary tuberculosis relative to silicosis and exposure to silica dust in South African gold miners. Occup Environ Med. 1998 Jul;55(7):496-502.	Cohort of white South African gold miners followed up from 1968 to December 1995	Silicosis Prevalence: PTB: 74,3% Rest of cohort: 54,4%	Exposure to silica dust is a risk factor for the development of PTB in the absence of silicosis, even after exposure to silica dust ends.
18. Trapido et al. Prevalence of Occupational Lung Disease in a Random Sample of Former Mineworkers, Libode District, Eastern Cape Province, South Africa American journal of industrial medicine 34:305-313 (1998)	Cross-sectional study of former migrant mineworkers to determine the prevalence of occupational lung disease and the previous compensation history.		High prevalence of radiological pneumoconiosis associated with length of service. Radiological evidence of pneumoconiosis, emphysema, and tuberculosis were all significantly associated with reduction in FEV1 and FVC. Very high prevalence of previously uncompensated work-related disease; lack of occupational health services in the areas to which most mineworkers return after leaving the mining industry.
19. Corbett et al. Pulmonary TB and Nontuberculous mycobacteria (NTM) lung disease: comparison of characteristics in patients with AFB smear-positive sputum. Am J Respir Crit Care Med. 1999 Jul;160(1):10-4. PubMed PMID: 10390373.	Retrospective case-control study to assess risk factors for NTM disease and TB in gold miners.	HIV Prevalence: 14,2% PTB cases	High incidence of NTM disease in miners is largely attributable to chronic chest disease from silica dust inhalation and prior TB and focal radiological scarring.
20. Corbett, EL. The impact of HIV infection on Mycobacterium kansasii disease in South African gold miners. Am j respir crit care med 1999;160:10–14.	Retrospective study of HIV-tested male mineworkers from whom a sputum specimen had grown NTM to determine the impact of HIV infection on the clinical and radiological characteristics of Mycobacterium kansasii disease.	HIV Prevalence: 19%	No significant effect of HIV infection on the bacteriological spectrum of NTM disease. M. kansasii in HIV positive males' disease occurred at a considerably lesser degree of immunosuppression and closely resembles disease in HIV-negative males.
21. Sonnenberg et al. Risk factors for pulmonary disease due to culture-positive M. tuberculosis or nontuberculous mycobacteria in South African gold miners. Eur Respir J 15 (2), 291-296. 2 2000	A case/control study comparing tuberculosis and NTM cases amongst all patients with a positive sputum mycobacterial culture to determine risk factors for disease due to NTM compared to those due to Mycobacterium tuberculosis.	HIV Prevalence: 48,8% Silicosis Prevalence: Possible: 14,9% Yes: 0,7%	Previous TB treatment, silicosis and duration of underground work are even more strongly associated with disease due to NTM than with TB. HIV-infected patients are at high risk for tuberculosis and both pulmonary and disseminated disease due to NTM.
22. Murray et al. Drug-resistant pulmonary tuberculosis in a cohort of Southern African Gold miners with a high prevalence of HIV infection. Afr. Med. J 2000; 90: 381-386	Prospective cohort study of patients with pulmonary TB to determine rates of drug resistance to Mycobacterium tuberculosis and associated risk factors.	HIV Prevalence: 48,7% MDR-TB Prevalence: New and Previous TB: 5,9% New TB: 0,3% TB Incidence: 1 296/100 000	Neither HIV infection nor the degree of immunosuppression was associated with drug resistance at the start or end of treatment. Previous treatment for TB was significantly associated with single- and multi-drug resistance.
23. Churchyard et al. Factors associated with an increased case-fatality rate in HIV-infected and non-infected South African gold miners with pulmonary tuberculosis. Int J Tuberc Lung Dis. 2000 May;4(5):433-40. PubMed PMID: 10815737.	A retrospective cohort study to investigate factors associated with an increased case-fatality rate (CFR) at 6 months in HIV positive and negative TB patients.	Silicosis Prevalence: HIV-positive: 12,6% HIV-negative: 7,1%	HIV infection and silicosis are both powerful risk factors for TB and are associated with an increased risk of death. Expanding the DOTS programme to include active case detection should be explored as a means of reducing TB prevalence and mortality.

24. Churchyard et al Drug-resistant tuberculosis in South African gold miners: incidence and associated factors. Int J Tuberc Lung Dis. 2000 May;4(5):433-40. PubMed PMID:10815737.	Retrospective review of Mycobacterium tuberculosis drug susceptibility records for the period from 1 July 1993 to 30 June 1997.	MDR-TB Prevalence: Primary: 0,1% Acquired: 0,2%	Pre-treatment single drug resistance, compared to fully susceptible TB, did not significantly predispose to treatment failure in patients with new or recurrent TB. Acquisition of new or additional drug resistance while on treatment may predispose to treatment failure. Adherence to and completion of treatment are essential for prevention of resistance and MDR.
25. Corbett et al. HIV infection and silicosis: the impact of two potent risk factors on the incidence of mycobacterial disease in South African miners. AIDS. 2000 Dec 1;14(17):2759-68	A retrospective cohort of HIV-positive and HIV negative miners to investigate the combined effects of HIV infection and silicosis on mycobacterial disease.	Silicosis Prevalence: < 30: 0,37% 30- to 39: 4,6% >40: 22,8% TB Incidence: HIV-positive: 4,9 per 100 PY's HIV-negative: 1,1 per 100 PY's	Risks of silicosis and HIV infection combine multiplicatively in HIV-positive miners. HIV-positive silicotics have considerably higher TB incidence rates than those reported from other HIV-positive Africans. The increasing impact of HIV over time may lead to epidemic TB transmission in HIV-infected miners. Need for adequate disease prevention and compensation of affected individuals.
26. Corbett et al. Polymorphisms in the Tumor Necrosis Factor - Gene Promoter May Predispose to Severe Silicosis in Black South African Miners. All AJRCCM Issues Vol. 165, No. 5 | Mar 01, 2002	An age–frequency-matched case–control study to compare Polymorphisms at positions 308, 238, and 376 in the TNF-α promoter region of patients with silicosis	Silicosis Prevalence: Early: 36% Moderate: 57% Severe: 7%	TNF-α promoter polymorphisms are associated with severe silicosis. Individual variation in the severity of chronic silicosis, but not overall susceptibility to the disease, may be partly explained by polymorphisms in the TNF-α promoter region.
27. Corbett et al. Morbidity and Mortality in South African Gold Miners: Impact of Untreated Disease Due to Human Immunodeficiency Virus. Clinical Infectious Diseases 2002; 34:1251–8	Prospective cohort of HIV–positive and HIV-negative gold miners to compare hospitalization and mortality rates.	HIV Prevalence: 24%	All-cause hospitalizations and deaths were significantly associated with HIV infection. A broad range of infectious conditions is significantly associated with HIV infection in South African miners.
28. Williams et al. Changing patterns of knowledge, reported behaviour and sexually transmitted infections in a South African gold mining community AIDS: 26 September 2003 - Volume 17 - Issue 14 - pp 2099-2107	Cross-sectional surveys among mineworkers, sex workers and adults in the community to investigate changes in sexual behaviour and the prevalence of STI before and 2 years after the start of the HIV prevention programme.	HIV Prevalence: mineworkers: 28,6% sex workers: 68,6% men: 20,2% women: 37,1%	There was little evidence of significant behaviour change and the prevalence of curable STI's increased. The prevention programme had had less impact than expected.
29. Day et al. Attitudes to HIV voluntary counselling and testing among mineworkers in South Africa: Will availability of antiretroviral therapy encourage testing? AIDS Care: Psychological and Socio-medical Aspects of AIDS/HIV Volume 15, 2003 - Issue 5	A cross-sectional descriptive survey to assess basic knowledge of HIV, awareness of personal risk of HIV and attitudes to VCT.		The level of basic knowledge of HIV was high, but reported awareness of the extent of HIV infection in the workforce and perceived personal risk of HIV infection was low. Barriers to VCT: denial of HIV risk, and fear of stigma, discrimination, disease and death.
30. Hermans et al. The timing of tuberculosis after isoniazid preventive therapy among gold miners in South Africa: a prospective cohort study .BMC Medicine 201614:45. DOI: 10.1186/s12916-016-0589-3	Randomised cluster controlled trial to compare the intervention or standard of care.	TB Incidence: On IPT: 1,3/100pyrs After IPT 2,3/100pyrs	Increased hazard of TB following IPT among participants who were older, doing underground rather than surface work or had had TB before
31. Meyer-Rath, et al. The Impact of Company-Level ART Provision to a Mining Workforce in South Africa: A Cost–Benefit Analysis. September 1, 2015http://dx.doi.org/10.1371/journal.pmed.1001869	Dynamic health-state transition model, called the Workplace Impact Model (WIM), was parameterised with workplace data on workforce size, composition, turnover, HIV incidence and CD4 cell count development	HIV Prevalence: 12,4%	Providing ART to workforce is cost-saving

32. Vynnycky et al. Tuberculosis Control in South African Gold Mines: Mathematical Modelling of a Trial of Community-Wide Isoniazid Preventive Therapy. American Journal of Epidemiology Advance Access published March 19, 2015	Mathematical model to look at: i) factors contributing to lack of population impact; ii) best achievable impact of Thibela TB, iii) what might control TB in gold mines		Tuberculosis control requires a combination prevention approach, including health systems strengthening to minimize treatment delay, improving diagnostics, increased antiretroviral treatment coverage, and effective preventive treatment regimens.
33. Knight et al. Trends in silicosis prevalence and the healthy worker effect among gold miners in South Africa: a prevalence study with follow-up of employment status BMC Public Health201515:1258 DOI: 10.1186/s12889-015-2566-8	Radiographs were read for TB according to ILO classification	Silicosis Prevalence: (ILO ≥1/0: 5,7 and 6.2 %)	No significant decline in overall silicosis prevalence among working black miners in the South African gold mining industry between 1984 and 2004–2009.
34. Nelson et al.. Three decades of silicosis disease: Trends at autopsy in South African Gold mines. Environ Health Perspect. 2010 Mar;118(3):421-6. doi: 10.1289/ehp.0900918.	Autopsy study of deceased miners	Silicosis Prevalence: White miners: 22% Black miners: 32%	
35. McCulloch Mine medicine: knowledge and power on South Africa's gold mines. Labor History; volume 54, issue 4: 421-435.2013	Commentary	Silicosis Prevalence: 22%-30%	Sixty percent of miners will develop silicosis.
36. Sonnenberg, et al. Quantifying errors in the estimation of tuberculosis mortality in a population of South African miners. Int J Tuberc Lung Dis 16(11):1449-54 · September 2012	Estimation of TB mortality from various sources: TB register, autopsy and death register		The TB specific mortality rate was 302/100 000 PY. These deaths included 191 (28%) on the TB register, 23 (3%) among defaulters/transfers, 153 (23%) after anti-tuberculosis treatment and 307 (46%) in men who had never been on the programme
37. Halsema, et al. Trends in drug-resistant tuberculosis in a gold-mining workforce in South Africa. Int J Tuberc Lung Dis. 2012 Jul;16(7):967-73. doi: 10.5588/ijtld.11.0122. Epub 2012 May 7	Analysed data for work TB program to look at XDR TB trends, 2002-2008 amongst goldminers		TB case notification rates decreased between 2002 and 2008 from 4 006 to 3 018 per 100 000 and from 3 192 to 2 468/100 000 for Companies A and B, respectively. HIV prevalence exceeded 80% in TB episodes with known status. The proportion of TB episodes with MDR-TB increased from 4,7% to 20,0% among previously treated cases, and from 10,4% to 25,0% in Companies A and B
38. Rees et al; Oscillating Migration and the Epidemics of Silicosis, Tuberculosis, and HIV Infection in South African Gold Miners. American journal of industrial medicine 53:398–404 (2010)	review of data on migration, silicosis, TB and HIV		In 1987, 0.03% of mineworkers from areas other than Malawi (seroprevalence 4%) tested HIV positive [Brink and Clausen, 1987]. This increased to 1,3% in 1990 [Petschel et al., 1993], rising to an estimated prevalence of 24% in 1999 [Charalambous et al., 2001] and reaching 27% in 2000 [Corbett et al., 2004]
39. Lewis et al. HIV Infection does not affect active case finding of tuberculosis in South African gold miners. Am J Respir Crit Care Med. 2009 Dec 15; 180(12): 1271–1278.	Data from miners attending annual medical examination was analysed	Silicosis Prevalence: 26% HIV Prevalence: 29%	
40. Hanifa et al. Prevalence of latent tuberculosis infection among gold miners in South Africa. Int J Tuberc Lung Dis. 2009 Jan;13(1):39-46. PubMed PMID: 19105877.	Latent TB?????		
41. McCulloch Counting the cost: gold mining and occupational disease in contemporary South Africa. African Affairs, 108/431, 221-240McCulloch Counting the cost: gold mining and occupational disease in contemporary South Africa. African Affairs, 108/431, 221-240	Overview of compensation in mining.		Using a cohort of Botswana miners who had worked in South Africa, a rate of silicosis of between 27% and 31% was found; of that number, almost 7% had life-threatening fibrosis. Anna Trapido's study on Libode, in the Eastern Cape, confirmed this data. Trapido estimates the prevalence of pneumoconiosis at between 22% and 36%. An industry-funded study by Churchyard et al. in the Free State found the prevalence of previously undiagnosed silicosis at between 18% and 23%. Jill Murray estimates that up to 60% of miners will eventually develop silicosis.

42. 2009 Bateman,	Overview of mining sector and TB	TB Incidence: 3 500/100 000	
43. Charalambous, et al. Contribution of reinfection to recurrent tuberculosis in South African gold miners. Int J Tuberc Lung Dis. 2008 Aug;12(8):942-8.	Followed up miners treated for TB between 1999 and Dec 2001, to look at recurrence		Among HIV-infected patients, lower CD4 count was associated with increased risk of TB recurrence (taking CD4 <200 as the reference group, CD4 200–500 Hazard ratio (HR) 0,4 [95%CI 0,1–1,1] and CD4 >500 HR 0,1 [95%CI 0.0–1,1], Ptrend = 0,01),
44. Churchyard et al. Factors associated with an increased case-fatality rate in HIV-infected and non-infected South African gold miners with pulmonary tuberculosis. Int j tuberc lung dis 4(8):705-712			Between April 1993 and March 1997, there were 2 236 men with culture-confirmed pulmonary TB of whom HIV status and treatment outcome were known. The overall Case Fatality Rate (CFR) within the first six months of therapy was low (3,6%). After adjusting for confounding factors, HIV infection (OR 15,0, 95%CI 7,4–30,6), self-presentation compared to detection by the active radiological screening programme (OR 5,6, 95%CI 2,6–12.2) and presence of silicosis (OR 3.0, 95%CI 1,4–6,3) were significantly associated with an increased CFR. Opportunistic infections accounted for 56,2% (36/64) of deaths in HIV-positive men. Cryptococcal disease accounted for 75% (27/36) of deaths from opportunistic infections
45. 2006 Steven et al		HIV Prevalence: 24,6%	
46. Sonnenberg, et al. The effect of HIV infection on time off work in a large cohort of gold miners with known dates of seroconversion. Occup Environ Med. 2011 Sep; 68(9): 647–652.	Retrospective cohort study of the association between HIV infection and first-episode pulmonary TB in a large cohort of gold miners in South Africa		TB incidence was 2,90 cases/100 person-years at risk (pyar) in HIV-positive miners and was 0,80 cases/100 pyar in HIV-negative miners (adjusted RR, 2,9 [95% confidence interval {CI}, 2,5–3,4]). TB incidence doubled within the first year of HIV infection (adjusted RR, 2.1 [95% CI, 1,4–3,1]), with a further slight increase in HIV positive miners for longer period, up to seven years
47. 1993 Murray et al	Case-control study of white miners with RVH who underwent a full necropsy between 1974 and 1988.	Silicosis Prevalence: Extensive: 7,7% Moderate: 12,0% Slight: 31,5%	Presence of silicosis is a risk factor for cor pulmonale in gold miners, but the risk increases with increasing severity of silicosis
48. Hnizdo et al. Emphysema and airway obstruction in non-smoking South African gold miners with long exposure to silica dust. Occupational and Environmental Medicine 1994;51:557-563	Necropsy study of South African white gold miners who were lifelong non-smokers.		Exposure to silica dust without a confounding effect of tobacco smoking is not associated with a degree of emphysema that would cause a statistically significant impairment of lung function. Silicosis of the lung parenchyma was associated with loss of lung function.
49. Hnizdoet al. Emphysema and airway obstruction in non-smoking South African gold miners with long exposure to silica dust. Occupational and Environmental Medicine 1994;51:557-563	Mortality study of white South African gold miners to assess the dose response relation between lung cancer and exposure to silica dust; the combined effect of tobacco smoking and respirable dust particle-years; the association between lung cancer and silicosis identified at necropsy.		Results showed a significant dose response relationship between death from lung cancer and silica dust particle-years and cigarette equivalent pack-years.Study confirmed an association between lung cancer and exposure to gold mining dust where high concentrations of silica dust is present.
50. Hnizdo et al. Lung cancer in relation to exposure to silica dust, silicosis and uranium production in South African gold miners. Thorax 1997;52:271-275	A nested case-control study of South African gold miners.		High level of exposure to silica dust early in life and a susceptibility to develop silicosis are associated with increased risk of lung cancer, and exposure to silica dust/silicosis acts synergistically with smoking on the risk of lung cancer.

51. Hnizdo. Loss of lung function associated with exposure to silica dust and with smoking and its relation to disability and mortality in South African gold miners. British Journal of Industrial Medicine 1992;49:472-479	A cohort of 2 209 white gold miners who were studied in 1968-71 for respiratory impairments and had follow-up lung function tests in five years.		Exposure to silica dust in South African gold mines is associated with a significant loss of lung function. Current smoking state was associated with the highest loss in lung function.
52. Charalambous et al. Persistent radiological changes following miliary tuberculosis in miners exposed to silica dust. Int j tuberc lung dis 5(11):1044-1050	Case series of 15 gold miners presenting with culture-positive milliary tuberculosis, serial radiographs taken premorbidly, at presentation, and after 2 and 6 months of standard anti-TB treatment were graded for nodularity using the ILO system.		Previous silica exposure results in delayed and potentially incomplete radiological resolution of milliary TB. Occupational dust control essential to decrease risk of TB and radiological silicosis.

"The silicosis rate was higher among white miners until early 2000. Overall the prevalence of silicososis ranged between 111 to 237 per 1000."

Annexure 2: Miners Autopsies in South Africa

The National Institute of Occupational Health (NIOH) conducts autopies on former miners as required by legislation. However, over the years the number of autopsies perfomed has decreased, see Figures 1, 2 and 3.

The areas with the highest number of autopsies perfomed are the ones where the highest number of miners are located, for example Rustenberg district and North West province, see Figure 4. Most of the autopsies were carried out on former miners from the gold industry, see Figure 5. The decrease in number of autopsies performed is particularly noticeable in the gold sector. Between 11% to 25% of autopsies performed are on those previously employed in the mining industry, see Table 1. The silicosis rate was higher among white miners until early 2000. Overall the prevalence of silicososis ranged between 111 to 237 per 1000.

Figure 1:
Miner autopsies by district and year (1998-2005)

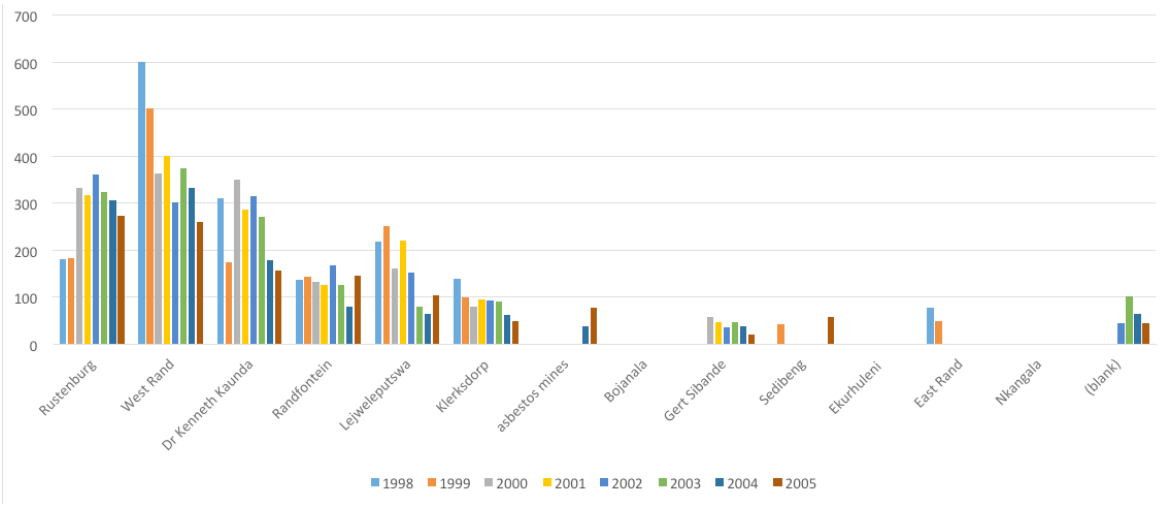


Figure 2:
Miner Autopsies by district and year (2006-2014)

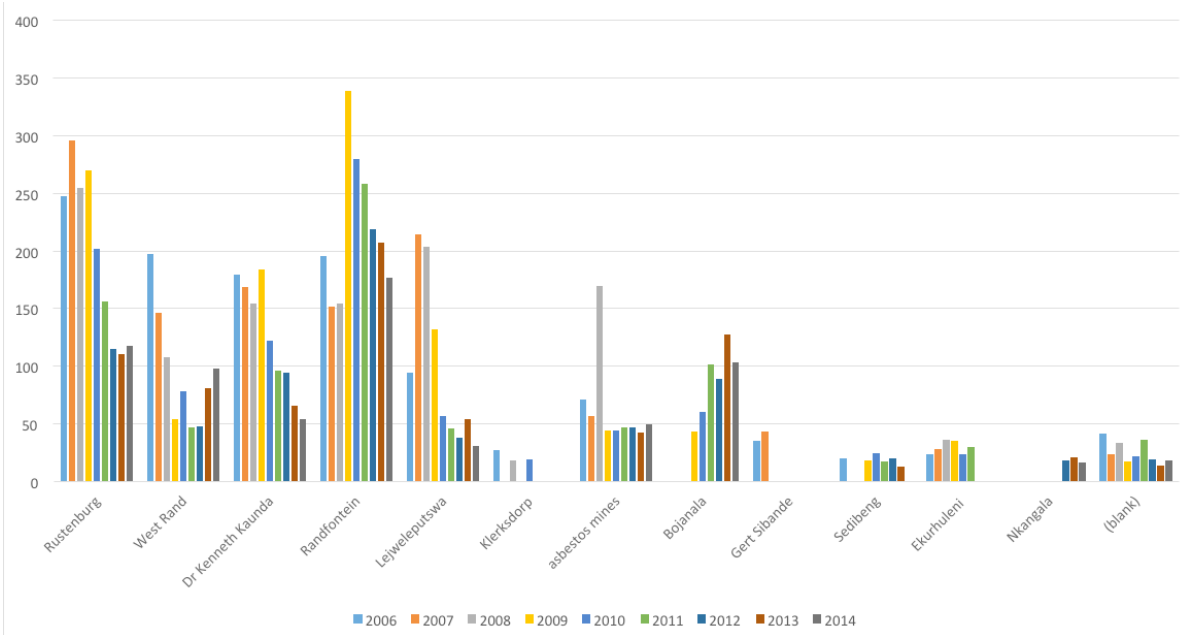


Figure 3:
Total miner autopsies by district (1998-2014)

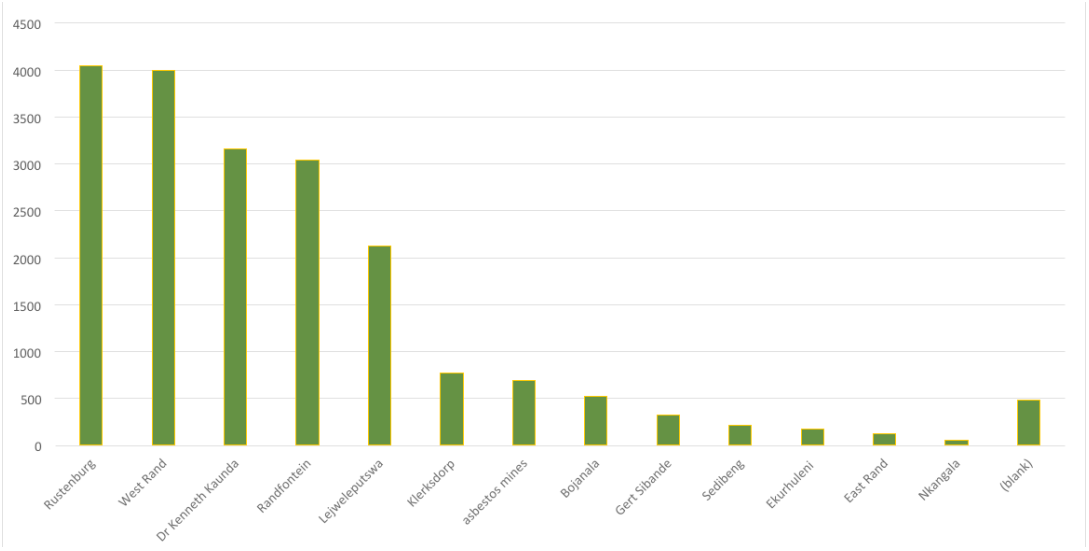


Figure 4:
Distribution of autopsies by province/country

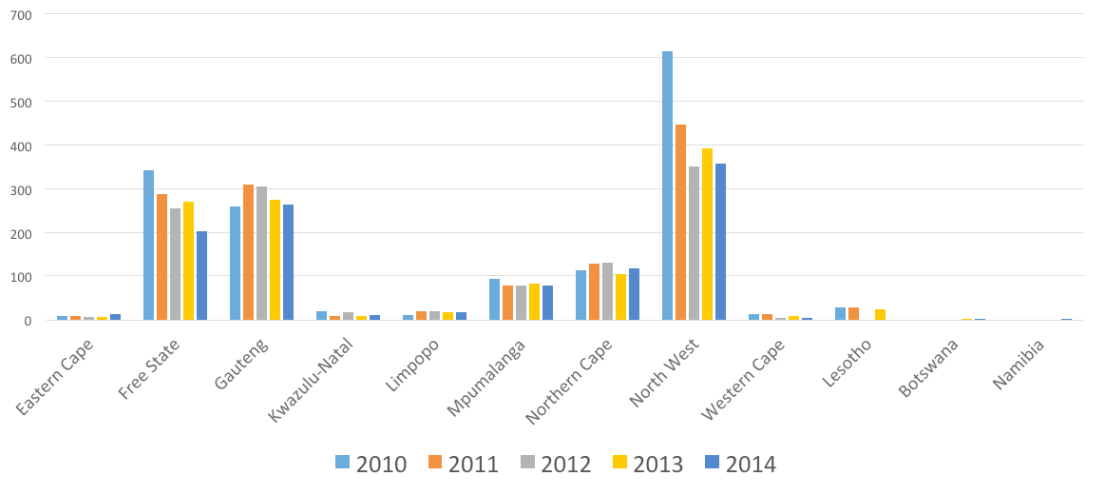
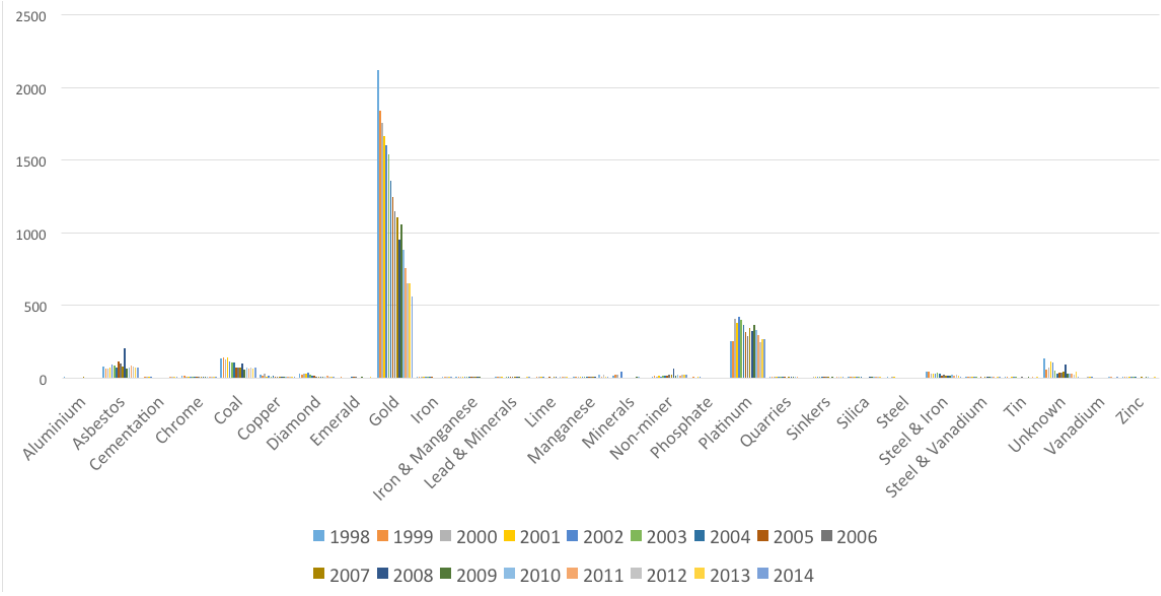


Figure 5:
Miner autopsy by commodity per year (1998-2014)



• **Table 1: Autopsies perfomed 1990- 2014 including among miners.**

Year	Total number of autopsies	Total number of autopsies on miners	% of all autopsies	Prevalence rate /1 000 autopsies	Black silicosis rate	White silicosis rate	Gold	Platinum	Coal	Asbesstos	Other	Black	White	Coloured	Others or unknown
1990	3 378	377	11	111	82	171	335	2	7	4	9	178	198	1	
1991	3 289	365	11,1	111	88	161	340	6	5	5	9	188	174	3	
1992	3 263	393	12	120	107	153	376	4	5	4	4	230	160	3	
1993	2 884	370	12,8	128	105	180	345	4	7	2	12	196	172	2	
1994	2 852	491	17,2	172	153	220	468	4	5	1	13	266	225	0	
1995	4 003	727	18,2	182	180	200	681	14	8	5	19	510	212	3	2
1996	1 128														
1997	3 208	481		149,9	157,4	141,6	447	8	1		25	350	127	1	3
1998	2 880	452	16	157	156	170	411	9	7	3	22	309	142		1
1999	2 529	336	13,3	132,9	127,4	147,8	315	6	2	3	13	211	123	1	1
2000	2 608	378	14,5	145	148	134	351	10	5	1	11	266	112	0	0
2001	2 529	436	17,2	172	169	183	390	16	10	1	19	266	149		1
2002	2 518	486	19,3	193	205	177	428	20	4	9	20	339	134	1	7
2003	2 318	437	18,9	189	202	166	400	13	5	4	15	310	124	1	2
2004	2 055	432	21	210	230	173	394	18	11	1	8	329	103	0	
2005	1 876	418	22,3	223	233	206	382	11	3	7	15	297	116	1	4
2006	1 720	409	23,8	238	238	245	372	17	4	5	11	277	131	1	
2007	1 724	395	22,9	229	246	202	348	19	3	9	16	281	109	2	3
2008	1 800	388	21,6	216	233	182	334	13	4	21	16	276	101	3	8
2009	1 662	394	23,7	237	257	200	355	25	3	5	6	293	100	1	
2010	1 502	350	23,3	233	253	202	307	14	4	5	20	243	105	0	2
2011	1 329	300	22,6	226	236	212	270	6	3	9	12	200	96	1	3
2012	1 164	294	25,3	234	241	274	259	17	2	8	8	170	122	0	2
2013	1 188	276	23,2	232	361	294	234	20	4	3	15	184	89	1	2
2014	1 066	206	19,3	193	207	176	181	15	4	2	4	130	76	0	0

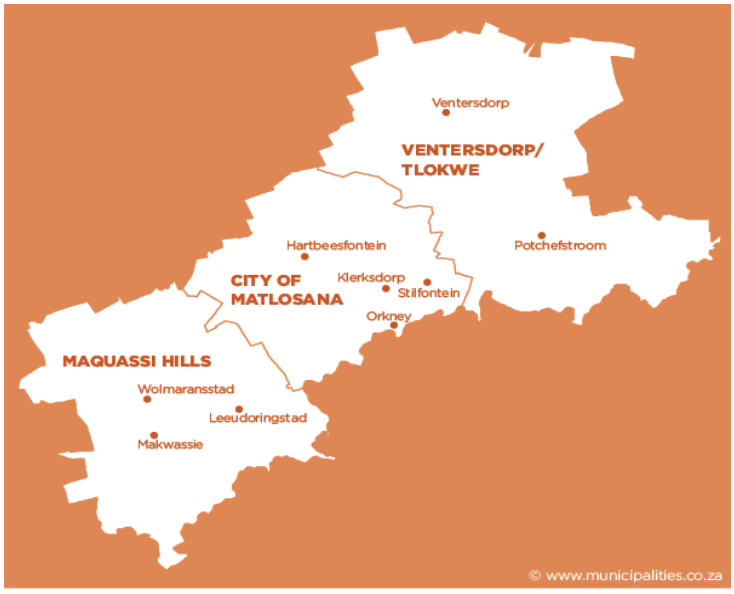
"The Copperbelt Province which holds the most copper mines in the region had a notification rate of 415 per 100000 people in 2013 which was more than 10-fold the national TB notification rate."

Annexure 3: Case Studies

Matlosana: TB in Peri-Mining Communities

Matlosana is a sub-district of the Dr Kenneth Kaunda Health District in the North West Province in South Africa (Figure 1). This sub-district, previously known as the Klerksdorp Municipality and officially renamed the City of Matlosana in 2005, was founded in the 1830s, around five decades before gold was discovered. Matlosana is 164km from Johannesburg along the N12 route, which also links it to the Northern Cape Province[2]. The Rustenburg platinum mining area is also only 120km from Matlosana. The areas that are part of Malotsana include Klerksdorp, Jouberton, Alabama, Orkney, Kanana, Vaal Reefs, Stilfontein, Khuma, Kanana, Tigane and Hartebeesfontein. Matlosana has an estimated total population size of 398 676 people of whom 92% are urbanised and 8% rural. The largest population concentrations are in Jouberton (31%), Kanana, Khuma and Tigane, which represents 67% of the total urban population.

Figure 1:
Map of Dr Kenneth Kaunda Distirct showing the three sub-districts



Matlosana is a mining community composed of in-country and cross-border migrants. Economic activity is predominantly mining of gold and associated industries (healthcare, schools, agriculture). The mining sector activities have been on a decline since the 1990s, with about 75% of the original workforce being retrenched by 2001, resulting in double the number of people living in poverty in 2011 compared to 1996. Although mining has declined, other economic activities like self-employment and research have increased, and many migrant, current and ex-mineworkers still live in the area. There are two public sector hospitals in Matlosana, administered as a single entity called the Klerksdorp Tshepong Hospital Complex (KTHC), four private hospitals and 16 primary care clinics. The hospitals act as a regional referral facility, receiving patients for some specialities from the entire North West Province.

The TB incidence in Dr Kenneth Kaunda District, for 2012 was 936/100 000, ranking it as the 11th highest TB incidence health district out of 56 in the country. A total of 3 531 people were diagnosed with TB in Matlosana in 2012 and 76% of TB patients were HIV co-infected. Data from a variety of sources show the severity of the HIV epidemic in Matlosana. Population HIV prevalence for North West province is estimated to be 13.3% and reports from 16 antenatal clinics in Matlosana suggested that 29% of pregnant women were HIV-infected. The Antenatal HIV seroprevalence for the Dr. Kenneth Kaunda Health District show HIV seroprevalence was 36% (95%CI 31.9-41.3) in 2011, which ranked it in the top quartile of antenatal HIV seroprevalence of the 52 South African health districts.

Several studies have been done by different research organizations within Matlosana in the general community, and four have been highlighted in Table 1. A post-mortem study showed that 31,8% of all home

deaths with uncategorised cause of death (CoD) had infectious TB[7]. In another study household contacts were followed-up a year after the initial contact, and this showed that the incidence of TB was higher among HIV-Infected (5,5/100 py) compared to HIV-negative (0,7/100py) individuals[2]. In the same cohort, the overal HIV incidence was 2,2/100py[2]. A contact-tracing study showed that household contacts of TB patients had high rates of undiagnosed TB, with a TB prevalence of 6 075 per 100 000, higher than the random household members (no TB contact) who had TB prevalence of 407 per 100 000[3]. Children in Matlosana are also at high risk of contracting TB. A survey of school-going children aged five years and seven years showed that latent tuberculisis Infection prevalence was 15% in the five-year-olds and 20% in the sevenyears-olds[4]. That makes the annual risk of contracting TB for these chidlren 2,9%[4].

In summary, Matlosana is a peri-mining community that is affected socially, environmentally and economically by the mining industry. The total workforce employed in the mines has declined, but the TB and HIV incidence and prevalence in this community is high compared to many areas in South Africa. Contact-tracing in this community identfies additional cases of TB and has shown that contacts of TB patients have a high prevalence of TB. Most of the TB and HIV rates reported in this community resemble mineworkers' HIV and TB disease burdens.

Table 1: Summary of published articles for Matlosana

Year	Methodology	Results
2015, T.Omar, E. Variava et al[1]	Mortuaries in Matlosana, identified eligible adults without an ante-mortem diagnosis and/or no recent hospital admission. A questionnaire was administered to next-of-kin. Bilateral lung core biopsies, and modified broncho-alveolar lavages (BAL) were performed.	Laboratory evidence of TB was found in 27(31,8%); 21 were Xpert positive, 23 were MGIT positive, and 14 had histological evidence consistent with TB.
2014, Cari van Schalkwyk et al[2]	Contacts of index TB patients received TB and HIV testing after counseling at their first household visit and were then followed up a year later, in 2010. New TB or HIV diagnoses that occurred during the period (One year after last follow-up) were determined.	The overall TB incidence rate was 1,3 per 100 person-years (95% CI 0,9–1,9/ 100py) and TB incidence for individuals who were HIV-infected and HIV seronegative at baseline was 5,4/100py (95% CI 2,9–9,0/100py) and 0.7/100py (95% CI 0.3–1.4/100py), respectively. The overall HIV incidence rate was 2,2/100py (95% CI 1,3–8,4/ 100py).
2012, Adrienne E. Shapiro et al[3]	A group of randomly selected control households were enrolled to determine community prevalence of undetected TB and HIV. Field teams screened participants for TB symptoms, collected sputum specimens for smear microscopy and culture, provided HIV counselling and testing, and collected blood for CD4 testing.	The prevalence of TB in household contacts was 6 075 per 100 000 (95% confidence interval, 5 789–6,360 per 100 000), whereas the prevalence detected in randomly selected households was 407 per 100 000 (95% confidence interval, 0–912 per 100,000; prevalence difference, 5 668 per 100 000; P < 0,001). TB detected among contacts was less likely to be smear-positive than in the index patients (6% vs. 22%; P < 0,001).
2015, Lebina et al[4]	This is a cross-sectional study to estimate the prevalence of latent tuberculous infection (LTBI) and the annual risk of tuberculous infection (ARTI) among a sample of children aged five and seven years in Matlosana, South Africa.	LTBI prevalence was significantly higher in children aged seven years (n = 704) (19,7%, 95%CI 16,75-22,65) than in those aged five years (212/1 401, 15,1%, 95%CI 13,23-16,97) (P = 0,0075). The ARI was 2,9% (95%CI 2,2-3,6).

References Matlosana

1. T. Omar, E. Variava, E. Moroe, A. Billioux, R. E. Chaisson, L. Lebina, N. Martinson (2015) Undiagnosed TB in adults dying at home from natural causes in a high TB burden setting: a post-mortem study.
2. Cari van Schalkwyk, Ebrahim Variava, Adrienne E. Shapiro, Modiehi Rakgokong, Katlego Masonoke, Limakatso Lebina, Alex Welte, Neil Martinson (2014). Incidence of TB and HIV in Prospectively Followed Household Contacts of TB Index Patients in South Africa.
3. Adrienne E. Shapiro, Ebrahim Variava, Modiehi H. Rakgokong,Neshen Moodley,Binnu Luke, Saeed Salimi, Richard E. Chaisson, Jonathan E. Golub, and Neil A. Martinson. (2012). Community-based Targeted Case Finding forTuberculosis and HIV in Household Contactsof Patients with Tuberculosis in South Africa.
4. 4. Lebina L, Abraham PM, Milanovic M, Motlhaoleng K, Chaisson RE, Rakgokong M, Variava E, Martinson NA. Tatent Tuberculosis Surveillance in School Children and Contact Tracining in Matlosana North West, South Africa. J. Tberc Lung Dis. 2015 Nov:19(11)

Zambia Copperbelt: Silicosis and Mining Impact

The Copperbelt province has a population of 1 972 317 accounting to 15.21% of the total Zambian population of 1 3 092 666 (census 2010). Silicosis and tuberculosis (TB) are major mining-related illnesses in developing countries including Zambia. The silica exposure levels and silicosis mobidity are not well documented among miners that have been employed in the copper mining in Zambia. The incidence rate of pulmonary tuberculosis (PTB) among current mines 1994–2014 was 658 per 100 000 populations. The rate increased from 1994 to 2005 but from 2005 it has steadily decreased. In 2014, the incidence rate of PTB among miners in Zambia was 288 per 100 000 populations. The Occupational Health and Safety Research Bureau of Zambia reported 2114 cases from 1945 to 2002. Of these, 22.7% were silicosis, 65.4% TB, and the remaining 11.9% silicotuberculosis. While silicosis cases decreased from 28.6% to 12.4% with the arrival of HIV/AIDS, there was a large increase in tuberculosis cases (37.1% to 86.1%), with a corresponding decrease in silicotuberculosis cases (34.3% to 1.6%).

The Copperbelt Province which holds the most copper mines in the region had a notification rate of 415 per 100000 people in 2013 which was more than 10-fold the national TB notification rate. The national prevalence survey also showed the Copperbelt Province to have the highest prevalence of bacteriologically confirmed TB of 1211 per 100 000 people in the general population. The Zambia National TB Prevalence Survey of 2013–2014 projected the prevalence rate of all forms of bacteriologically confirmed pulmonary TB (PTB) among those aged 15 years and above to be at 638 per 100 000 populations.

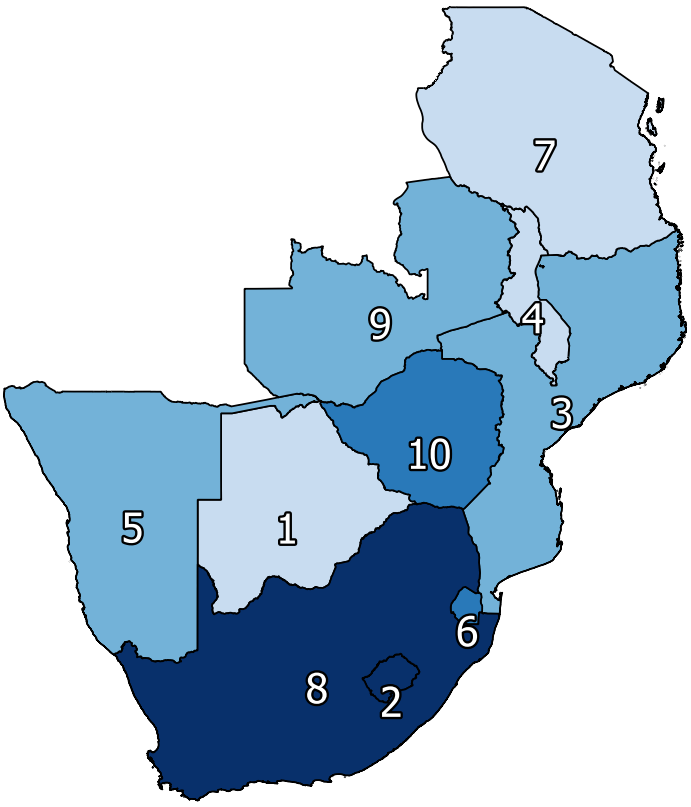
Table 2: Summary of published literature on mining and Copperbelt in Zambia

Year	Methodology	Results
2016, Kingsley Ngosa and Rajen Naidoo	A cross sectional study of in-serviceminers. A systematic review of medical data over a five years period of silica exposure	The median respirable silica dust level was 0.3 mg/m(3) (range 0.1-1.3). The overall prevalence of PTB was 9.5 % (n=34). High cumulative respirable silica dust category showed a statistically significant association with PTB (OR=6.4 (95 % CI 1. 8-23)) and a significant trend of increasing disease prevalence with increasing cumulative respirable silica dust categories was observed (ptrend<0.01). Smoking showed a statistically significant association with PTB with OR=4.3 (95 % CI 1.9-9.9).
Mulenga et al, 2005	he purpose of this study was to examine annual cases of these diseases in Zambian miners including comparison of periods before (1960–1970) and after (1992–2002)	The Occupational Health and Safety Research Bureau of Zambia reported 2114 cases from 1945 to 2002. Of these, 22.7% were silicosis, 65.4% TB, and the remaining 11.9% silicotuberculosis. While silicosis cases decreased from 28.6% to 12.4% with the arrival of HIV/AIDS, there was a large increase in tuberculosis cases (37.1% to 86.1%), with a corresponding decrease in silicotuberculosis cases (34.3% to 1.6%)
Patrick Hayumbu et al, 2005	A cross- sectional survey to measure silica exposure in two Zambian mines, Nkana and Mufulira	The mean intensities of respirable dust exposure at Mufulira and Nkana were 0.992 mg/m^3 (range 0–7.674) and 0.868 mg/m^3 (range 0–6.944), respectively while the mean intensities of respirable quartz at Mufulira and Nkana were 0.143 mg/m^3 (range 0–1.302) and 0.060 mg/m^3 (range 0–0.317), respectively

References

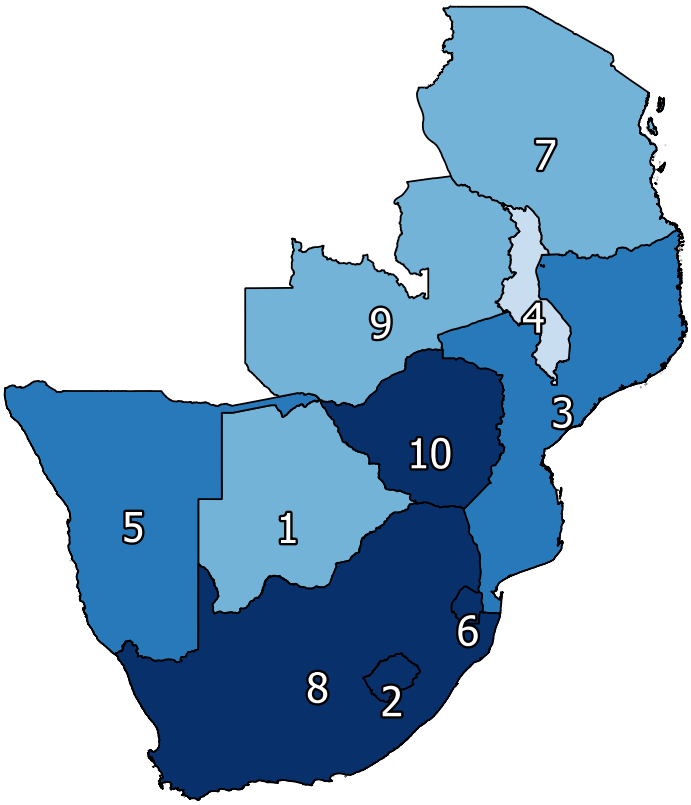
1. Ngosa K, Naidoo RN. The risk of pulmonary tuberculosis in underground copper miners in Zambia exposed to respirable silica: a cross sectional study. BMC public health 2016;16:855
2. Mutenga EM, Miller HB, Sinkala T, et al. Silicosis and Tuberculosis in Zambia miners. International Journal of Occupational and Environmental Health. 2005 Jul-Sep: 11(3):259-62
3. Hayumbu P, Robins TG, Key-Schwartz. Cross-Sectional silica exposure measurement at two Zambian Copper mines of Nkana and Mufulira. Int J. Environ. Res. Public Health 2008, 5(2), 86-90.

Annexure 4: Map of TB incidence



ID	Country
1	Botswana
2	Lesotho
3	Mozambique
4	Malawi
5	Namibia
6	Swaziland
7	Tanzania
8	South Africa
9	Zambia
10	Zimbabwe

General Population



TB Incidence (per 100,000)

- 0 - 200
- 200 - 400
- 400 - 600
- 600 - 800
- >800

Mine Workers

Annexure 5: Baseline indicators

Botswana

TABLE A5.1: BOTSWANA GENERAL POPULATION

Indicators	Population sizes	General Incidence	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimated number of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)	TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases
General Population	23 753 14	385	347	2,5%	6019
Bobonong	17 720	385	347	2,5%	45
Barolong	57 980	385	347	2,5%	147
Boteti	60 671	356	320	2,5%	253
Central Boronong	76 068	385	347	2,5%	193
Chobe	24 688	243	219	2,5%	60
Francistown	104 645	314	283	2,5%	329
Gaborone	244 894	284	256	2,5%	697
Ghanzi	45 570	615	554	2,5%	257
Jwaneng	19 042	520	468	2,5%	99
Kgalagadi	31 740	385	347	2,5%	80
Kgalagadi North	21 652	517	465	2,5%	112
Kgatleng	96 925	333	300	2,5%	323
Kweneng East	271 499	370	333	2,5%	1004
Kweneng West	50 542	271	244	2,5%	137
Lobatse	30 673	345	311	2,5%	106
Mabutsane	2 386	428	385	2,5%	62
Mahalapye	125 703	228	205	2,5%	287
Ngamiland East	95 522	267	240	2,5%	255
Ngamiland West	62 834	267		2,5%	255
Ngwaketse	136 670	385	347	2,5%	346
North East	63 725	223	201	2,5%	142
Okavango	2 674	223	201	2,5%	146
Orapa	52 249	385	347	2,5%	132
Selebi Phikwe	52 000	228	205	2,5%	119
Serowe Palapye	190 867	369	332	2,5%	335
South East	89 897	302	272	2,5%	272
Southern	186 831	385	347	2,5%	473
Sowa	3 805	385	347	2,5%	10
Tutume	15 5842	158	142	2,5%	217

MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB , N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)	HIV Prevalence (Overall) (%)
100	91%	60%	78%	17,1%
1	91%	60%	78%	39,6%
2	91%	60%	78%	17,7%
3	91%	85%	88%	20,0%
3	91%	60%	78%	16,7%
1	91%	60%	78%	39,3%
4	91%	94%	71%	20,1%
10	91%	96%	81%	19,9%
2	91%	98%	81%	16,5%
1	91%	98%	91%	12,7%
1	91%	60%	78%	11,5%
1	91%	88%	88%	15,4%
4	91%	95%	80%	19,0%
11	91%	91%	68%	10,6%
2	91%	93%	69%	11,5%
1	91%	97%	93%	16,6%
0	91%	94%	97%	19,5%
5	91%	95%	80%	24,5%
4	91%	95%	82%	14,8%
3	91%	95%	82%	13,9%
6	91%	60%	78%	17,0%
3	91%	99%	95%	16,4%
0	91%	97%	94%	2,0%
2	91%	60%	78%	14,7%
2	91%	100%	99%	27,7%
8	91%	95%	84%	17,3%
4	91%	97%	73%	15,8%
8	91%	60%	78%	11,8%
0	91%	60%	78%	18,2%
7	91%	99%	88%	16,6%

TABLE A5.2: BOTSWANA MINEWORKERS

Indicators	Population sizes (TEBA Data)	Population Sizes	General Incidence/ 100,000	TB Incidence rate in miners/ 100,000	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimatednumber of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)
Population of miners	29 043	20253	385	501	450	2,5%
Bobonong	377		385	512	461	2,5%
Lethakane	817		385	512	461	2,5%
Mahalapye East	702		228	303	273	2,5%
Mahalapye West	1 225		228			2,5%
Palapye	801		222	295	266	2,5%
Selebi-Phikwe	446		228	303	273	2,5%
Serowe	874		369	491	442	2,5%
Sowa	2		385	512	461	2,5%
Tonota	320		607	807	727	2,5%
Tutume	1 034		158	210	189	2,5%
Ghanzi	0		615	818	736	2,5%
Kgalagadi North	101		517	688	619	2,5%
Kgalagadi South	85		438	583	524	2,5%
Kgatleng	1 311		333	443	399	2,5%
Kweneng North	5 305		385	512	461	2,5%
Kweneng South	3 276		385	512	461	2,5%
Kweneng West	852		271	360	324	2,5%
Francistown	200		314	418	376	2,5%
Tati	826		385	512	461	2,5%
Chobe	11		243	323	291	2,5%
Ngamiland East	76		267	355	320	2,5%
Ngamiland West	113		267			2,5%
Bamalete-Tlokweng	3 069		385	512	461	2,5%
Barolong	931		385	512	461	2,5%
Ngwaketse Central	602		385	512	461	2,5%
Ngwaketse North	3 214		385	512	461	2,5%
Ngwaketse South	994		385	512	461	2,5%
Ngwaketse West	1 477			512	461	2,5%

TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases	MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB , N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)
145	4	91%	60%	78%
2	0,0	91%	60%	78%
4	0	91%	60%	78%
2	0	91%	60%	78%
		91%	60%	78%
2	0	91%	60%	78%
1	0	91%	60%	78%
4	0	91%	60%	78%
0	0	91%	60%	78%
3	0	91%	60%	78%
2	0	91%	60%	78%
0	0	91%	60%	78%
1	0	91%	60%	78%
0	0	91%	60%	78%
6	0	91%	60%	78%
27	1	91%	60%	78%
17	0	91%	60%	78%
3	0	91%	60%	78%
1	0	91%	60%	78%
4	0	91%	60%	78%
0	0	91%	60%	78%
0	0	91%	60%	78%
		91%	60%	78%
16	0	91%	60%	78%
5	0	91%	60%	78%
3	0	91%	60%	78%
16	0	91%	60%	78%
5	0	91%	60%	78%
8	0	91%	60%	78%

Lesotho

TABLE A5.3: LESOTHO GENERAL POPULATION

Indicators	Population sizes	General TB Incidence	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimated number of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)	TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases	MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB), N=Cases
General Population	2 100 000	852	717,0	3,2%	9 856	220
Maseru	492 138	537	451,9	3,2%	2 578	58
Berea	309 727	443	372,8	3,2%	1 147	26
Leribe	373 431	410	345,0	3,2%	1 215	27
Butha Buthe	130 813	404	340,0	3,2%	422	9
Mokhotlong	92 436	246	207,0	3,2%	260	6
Qacha's Nek	82 768	414	348,4	3,2%	287	6
Thaba Tseka	14 406	217	182,6	3,2%	297	7
Quthing	144 922	270	227,2	3,2%	320	7
Mohale's Hoek	213 139	384	323,1	3,2%	656	15
Mafeteng	246 220	388	326,5	3,2%	709	16

TABLE A5.4: LESOTHO MINEWORKERS

Indicators	Population sizes - Mapping Studies	Population sizes - TEBA Data	General Incidence/ 100,000	TB Incidence rate in miners/ 100,000	TB Incidence rate in miners/ 100,000	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)
Population of miners	15 911	192 047	852	1133	1133	952
Maseru	3 317	37 396	537	714	714	600
Berea	1 809	20 855	443	589	589	495
Leribe	3 223	21 431	410	545	545	458
Butha Buthe	1 088	13 456	404	537	537	451
Mokhotlong	346	8 321	246	327	327	275
Qacha's Nek	417	8 656	414	551	551	463
Thaba Tseka	358	5 125	217	289	289	242
Quthing	819	14 611	270	359	359	302
Mohale's Hoek	1 782	33 070	384	511	511	429
Mafeteng	2 752	29 126	388	516	516	433

TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)	HIV Prevalence in Adults (15-49 years old) (%)
93%	93%	72%	74%	23%
90%	90%	74%	78%	28%
84%	84%	74%	84%	25.4%
97%	97%	73%	70%	25.4%
92%	92%	72%	87%	21.2%
97%	97%	74%	84%	17%
98%	98%	68%	80%	20.9%
91%	91%	72%	75%	24.7%
97%	97%	68%	78%	20.8%
96%	96%	70%	86%	20.1%
99%	99%	68%	83%	25.1%

TB O-3: Proportion of estimatednumber of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)	TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases (2015 TB Data Report)	MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB , N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)
3,2%	771	25	93%	72%
3,2%	154	5	90%	74%
3,2%	76	2	84%	74%
3,2%	114	4	97%	73%
3,2%	74	2	92%	72%
3,2%	33	1	97%	74%
3,2%	38	1	98%	68%
3,2%	54	2	91%	72%
3,2%	30	1	97%	68%
3,2%	62	2	96%	70%
3,2%	136	4	99%	68%

Malawi

TABLE A5.5: MALAWI GENERAL POPULATION

Indicators	Population sizes	General TB Incidence	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimatednumber of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)	TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases
General Population	17 000 000	227	220	0,42%	17 723
Balaka	383 887	651,9	632	0,42%	2 503
Blantrye	849 741	908,3	881	0,42%	7 718
Chikwawa	518 287	612,5	594	0,42%	3 175
Chiradzulu	314 059	612,5	594	0,42%	1 924
Neno	158 000	227	220	0,42%	359
Phalombe	231 990	227	220	0,42%	527
Others	14 544 036	160,0	155	0,42%	2 404

TABLE A5.6: MALAWI MINEWORKERS

Indicators	Population sizes	General Incidence/100,000	TB Incidence rate in miners/100,000	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimatednumber of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)
Population of miners	5 4000	227	301,9	267,8	0,42%

MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/ or MDR-TB , N=Cases	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)	HIV Prevalence (Overall) (%)
47	54%	93%	92%	10.8%
1	54%	93%	92%	13.8%
2	54%	93%	92%	17.8%
1	54%	93%	92%	13.4%
1	54%	93%	92%	19%
2	54%	93%	92%	
2	54%	93%	92%	
40	54%	93%	92%	

TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases	MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB , N=Cases	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)
163	1	54%	92%

Mozambique

TABLE A5.7: MOZAMBIQUE GENERAL POPULATION

Indicators	Population sizes	General Incidence of TB	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimatednumber of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)	TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases
General Population	27 978 000	551	495,9	3,5%	60 340
PROVINCE					
Cabo Delgado	1 923 300	134	120,6	3,5%	4 148
Gaza	1 442 100	337	303,3	3,5%	3 110
Inhambane	1 523 600	223	200,7	3,5%	3 286
Manica	2 001 900	193	173,7	3,5%	4 317
Maputo	1 782 400	376	338,4	3,5%	3 844
Nampula	5 130 000	138	124,2	3,5%	11 064
Niassa	1 722 100	98	88,2	3,5%	3 714
Sofala	2 099 200	379	341,1	3,5%	4 527
Tete	2 618 900	142	127,8	3,5%	5 648
Zambézia	4 922 700	166	149,4	3,5%	10 617
Cidade de Maputo	1 257 500	551	495,9	3,5%	2 712
DISTRICT					
Ancuabe	117 488	551	495,9	3,5%	8 836
Balama	137 506	551	495,9	3,5%	10 341
Chiure	238 297	551	495,9	3,5%	17 921
Cidade De Pemba	174 572	551	495,9	3,5%	13 129
Ibo	10 828	551	495,9	3,5%	814
Macomia	87 283	551	495,9	3,5%	6 564
Mecufi	47 141	551	495,9	3,5%	3 545
Meluco	25 882	551	495,9	3,5%	1 946
Mocimboa Da Praia	101 613	551	495,9	3,5%	7 642
Montepuez	217 736	551	495,9	3,5%	16 375
Mueda	123 800	551	495,9	3,5%	9 310
Muidumbe	77 489	551	495,9	3,5%	5 828
Namuno	201 807	551	495,9	3,5%	15 177
Nangade	69 100	551	495,9	3,5%	5 197
Palma	51 438	551	495,9	3,5%	3 868
Pemba	75 425	551	495,9	3,5%	5 672
Quissanga	39 928	551	495,9	3,5%	3 003
Bilene	163 386	551	495,9	3,5%	12 287
Chibuto	207 210	551	495,9	3,5%	15 583
Chicualacuala	42 542	551	495,9	3,5%	3 199
Chigubo	25 803	551	495,9	3,5%	1 941
Chokwe	196 671	551	495,9	3,5%	14 791
Cidade De Xai-Xai	124 216	551	495,9	3,5%	9 342
Guija	86 567	551	495,9	3,5%	6 510
Mabalane	36 121	551	495,9	3,5%	2 716

MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB , N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	HIV Prevalence (Overall) (%)	HIV Prevalence in Adults (15-49 years) (%)
1 700	93%	81%	52%	11%	11,6%
117	93%	81%	52%	6%	9,4%
88	93%	81%	52%	12%	25,1%
93	93%	81%	52%	4%	8,6%
122	93%	81%	52%	9%	8,6%
108	93%	81%	52%	9%	19,8%
312	93%	81%	52%	8%	4,6%
105	93%	% 81%	52%	2%	3,7%
128	93%	81%	52%	11%	15,5%
159	93%	81%	52%	5%	7%
299	93%	81%	52%	20%	12,6%
76	93%	81%	52%	9%	16,8%
0	93%	81%	52%		
0	93%	81%	52%		
0	93%	81%	52%		
0	93%	81%	52%		
0	93%	81%	52%		
0	93%	81%	52%		
0	93%	81%	52%		
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0	93%	81%	52%		
0	93%	81%	52%		
0	93%	81%	52%		
0	93%	81%	52%		
0	93%	81%	52%		
0	93%	81%	52%		
0	93%	81%	52%		

Continued... Table A5.7: Mozambique General population

Mandlakaze/ Manjacaze	175 607	551	495,9	3,5%	13206
Massangena	17 287	551	495,9	3,5%	1300
Massingir	32 384	551	495,9	3,5%	2435
Xai-Xai	236 306	551	495,9	3,5%	17771
Cidade de Maxixe	121 097	551	495,9	3,5%	9107
Cidade De Inhambane	73 948	551	495,9	3,5%	5561
Funhalouro	44 320	551	495,9	3,5%	3333
Govuro	39 344	551	495,9	3,5%	2959
Homoine	121 512	551	495,9	3,5%	9138
Inharrime	116 285	551	495,9	3,5%	8745
Inhassoro	55 740	551	495,9	3,5%	4192
Jangamo	105 032	551	495,9	3,5%	7899
Mabote	49 867	551	495,9	3,5%	3750
Massinga	199 156	551	495,9	3,5%	14977
Morrumbene	140 322	551	495,9	3,5%	10553
Panda	51 317	551	495,9	3,5%	3859
Vilankulo	155 134	551	495,9	3,5%	11667
Zavala	153 611	551	495,9	3,5%	11552
Barue	188 444	551	495,9	3,5%	14172
Cidade De Chimoio	285 716	551	495,9	3,5%	21487
Gondola	310 429	551	495,9	3,5%	23346
Guro	83 972	551	495,9	3,5%	6315
Machaze	122 801	551	495,9	3,5%	9235
Macossa	37 983	551	495,9	3,5%	2856
Manica	257 419	552	496,8	3,5%	19359
Mossurize	246 225	551	495,9	3,5%	18517
Sussundenga	152 646	551	495,9	3,5%	11480
Tambara	49 716	551	495,9	3,5%	3739
Boane	134 006	551	495,9	3,5%	10078
Cidade Da Matola	827 475	551	495,9	3,5%	62230
Magude	59 162	551	495,9	3,5%	4449
Manhica	214 751	551	495,9	3,5%	16150
Marracuene	118 949	551	495,9	3,5%	8945
Matutuine	39 932	551	495,9	3,5%	3003
Moamba	64 147	551	495,9	3,5%	4824
Namaacha	48 019	551	495,9	3,5%	3611
Angoche	311 241	551	495,9	3,5%	23407
Cidade De Nampula	571 284	551	495,9	3,5%	42963
Ilha De Mozambique	52 962	551	495,9	3,5%	3983
Lalaua	83 231	551	495,9	3,5%	6259
Malema	185 839	551	495,9	3,5%	13976
Meconta	178 468	551	495,9	3,5%	13422
Mecuburi	175 846	551	495,9	3,5%	13224
Memba	253 531	551	495,9	3,5%	19067
Mogincual	152 091	551	495,9	3,5%	11438
Mogovolas	349 644	551	495,9	3,5%	26295
Moma	349 864	551	495,9	3,5%	26311
Monapo	351 012	551	495,9	3,5%	26398
Mossuril	131 356	551	495,9	3,5%	9879

372	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
422	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
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0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
323	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
176	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
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0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%

Continued... Table A5.7: Mozambique General population

Muecate	107 614	551	495,9	3,5%	8093
Murrupula	162 673	551	495,9	3,5%	12234
Cidade de Nacala-Porto	231 336	551	495,9	3,5%	17398
Nacala-A-Velha	106 543	551	495,9	3,5%	8013
Nacaroa	119 893	551	495,9	3,5%	9016
Erati	291 706	551	495,9	3,5%	21938
Nampula	253 294	551	495,9	3,5%	19049
Ribaue	228 411	551	495,9	3,5%	17178
Cidade De Lichinga	186 490	551	495,9	3,5%	14025
Cuamba	222 800	551	495,9	3,5%	16756
Lago	101 082	551	495,9	3,5%	7602
Lichinga	114 024	551	495,9	3,5%	8575
Majune	35 248	551	495,9	3,5%	2651
Mandimba	164 826	551	495,9	3,5%	12396
Marrupa	63 078	551	495,9	3,5%	4744
Maua	57 610	551	495,9	3,5%	4333
Mavago	25 141	551	495,9	3,5%	1891
Mecanhelas	219 183	551	495,9	3,5%	16484
Mecula	16 032	551	495,9	3,5%	1206
Metarica	46 512	551	495,9	3,5%	3498
Muembe	34 555	551	495,9	3,5%	2599
Ngauma	85 569	551	495,9	3,5%	6435
Nipepe	34 710	551	495,9	3,5%	2610
Sanga	65 527	551	495,9	3,5%	4928
Buzi	179 621	551	495,9	3,5%	13508
Caia	135 773	551	495,9	3,5%	10211
Chemba	73 390	551	495,9	3,5%	5519
Cheringoma	49 504	551	495,9	3,5%	3723
Chibabava	121 154	551	495,9	3,5%	9111
Cidade Da Beira	456 005	551	495,9	3,5%	34294
Dondo	161 752	551	495,9	3,5%	12164
Gorongosa	143 518	551	495,9	3,5%	10793
Machanga	58 873	551	495,9	3,5%	4428
Maringue	86 738	551	495,9	3,5%	6523
Marromeu	150 416	551	495,9	3,5%	11312
Muanza	32 300	551	495,9	3,5%	2429
Nhamatanda	254 683	551	495,9	3,5%	19153
Angonia	348 989	551	495,9	3,5%	26246
Cahora Bassa	109 121	551	495,9	3,5%	8206
Changara	183 596	551	495,9	3,5%	13807
Chifunde	137 860	551	495,9	3,5%	10368
Chiuta	89 595	551	495,9	3,5%	6738
Cidade De Tete	190 815	551	495,9	3,5%	14350
Macanga	163 149	551	495,9	3,5%	12270
Magoe	87 465	551	495,9	3,5%	6578
Maravia	99 563	551	495,9	3,5%	7488
Moatize	292 341	551	495,9	3,5%	21985
Mutarara	250 549	551	495,9	3,5%	18842
Tsangano	205 100	551	495,9	3,5%	15424
Zumbu	70 384	551	495,9	3,5%	5293
Alto Molocue	332 775	551	495,9	3,5%	25026
Chinde	129 555	551	495,9	3,5%	9743

0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
226	93%	81%	52%
0	93%	81%	52%
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0	93%	81%	52%
0	93%	81%	52%
966	93%	81%	52%
0	93%	81%	52%
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404	93%	81%	52%
0	93%	81%	52%
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0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%

Continued... Table A5.7: Mozambique General population

Cidade De Quelimane	224 808	551	495,9	3,5%	16907
Gile	188 726	551	495,9	3,5%	14193
Gurue	363 959	551	495,9	3,5%	27371
Ile	318 382	551	495,9	3,5%	23944
Inhassunge	97 711	551	495,9	3,5%	7348
Lugela	148 025	551	495,9	3,5%	11132
Maganja Da Costa	301 916	551	495,9	3,5%	22705
Milange	588 840	551	495,9	3,5%	44283
Mocuba	355 299	551	495,9	3,5%	26720
Mopeia	141 029	551	495,9	3,5%	10606
Morrumbala	422 309	551	495,9	3,5%	31760
Namacurra	229 290	551	495,9	3,5%	17244
Namarroi	140 605	551	495,9	3,5%	10574
Nicoadala	250 182	551	495,9	3,5%	18815
Pebane	210 793	551	495,9	3,5%	15853
Cidade De Maputo	1 194 121	551	495,9	3,5%	89803

0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
675	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
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0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%
0	93%	81%	52%

Mozambique

TABLE A5.8: MOZAMBIQUE MINEWORKERS

Indicators	Population size of miners	General Incidence/ 100,000	TB Incidence rate in miners/100,000	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimatednumber of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)
Population of miners	174 906	551	733	660	3,5%
Bilene	9 371	551	733	660	3,5%
Chibuto	18 480	551	733	660	3,5%
Chicualacuala	127	551	733	660	3,5%
Chigubo	33	551	733	660	3,5%
Chokwe		551	733	660	3,5%
Cidade De Xai-Xai		551	733	660	3,5%
Guija	3 635	551	733	660	3,5%
Mabalane	96	551	733	660	3,5%
Mandlakaze/ Manjacaze	11 707	551	733	660	3,5%
Massangena	50	551	733	660	3,5%
Massingir		551	733	660	3,5%
Xai-Xai	26 419	551	733	660	3,5%
Cidade de Maxixe	1 949	551	733	660	3,5%
Funhalouro	175	551	733	660	3,5%
Govuro	1 175	551	733	660	3,5%
Homoine	7 394	551	733	660	3,5%
Inharrime	3 274	551	733	660	3,5%
Jangamo	1 199	551	733	660	3,5%
Mabote	229	551	733	660	3,5%
Morrumbene	5 179	551	733	660	3,5%
Panda	1 783	551	733	660	3,5%
Zavala	7 681	551	733	660	3,5%
Boane	274	551	733	660	3,5%
Cidade Da Matola	8 239	551	733	660	3,5%
Magude	3 145	551	733	660	3,5%
Manhica	4 565	551	733	660	3,5%
Marracuene	943	551	733	660	3,5%
Matutuine		551	733	660	3,5%
Moamba	1 859	551	733	660	3,5%
Namaacha	166	551	733	660	3,5%
Cidade De Maputo	24 264	551	733	660	3,5%

TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases	TB O-3: Proportion of estimatednumber of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)	MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB , N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)	TB/HIV-2: HIV-Posit
1 282	3,5%	0	93%	81%	
69	69	2	93%	81%	
135	135	5	93%	81%	
1	1	0	93%	81%	
0	0	0	93%	81%	
0	0	0	93%	81%	
0	0	0	93%	81%	
27	27	1	93%	81%	
1	1	0	93%	81%	
86	86	3	93%	81%	
0	0	0	93%	81%	
0	0	0	93%	81%	
194	194	7	93%	81%	
14	14	1	93%	81%	
1	1	0	93%	81%	
9	9	0	93%	81%	
54	54	2	93%	81%	
24	24	1	93%	81%	
9	9	0	93%	81%	
2	2	0	93%	81%	
38	38	1	93%	81%	
13	13	0	93%	81%	
56	56	2	93%	81%	
2	2	0	93%	81%	
60	60	2	93%	81%	
23	23	1	93%	81%	
33	33	1	93%	81%	
7	7	0	93%	81%	
0	0	0	93%	81%	
14	14	0	93%	81%	
1	1	0	93%	81%	
178	178	6	93%	81%	

Namibia

TABLE A5.9: NAMIBIA MINE WORKERS - PROVINCES

Indicators	Population sizes	General Incidence/ 100,000	TB Incidence rate in miners/100,000	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimatednumber of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)
Population of miners	**19 000**	**561**	**746**	**592**	**3,8%**
PROVINCE					
Erongo	5 004	263	350	278	3,8%
Hardap	81	288	383	304	3,8%
IKaras	2 263	325	432	343	3,8%
Kavango	54	182	242	192	3,8%
Khomas	1 368	179	238	189	3,8%
Kunene	314	119	158	126	3,8%
Ohangwena		170	226	180	3,8%
Omaheke	27	181	241	191	3,8%
Omusati	128	110	146	116	3,8%
Oshana	178	186	247	196	3,8%
Oshikoto	1 832	151	201	159	3,8%
Otjozondjupa	2 310	222	295	234	3,8%
Others	5 441	561	746	592	3,8%

NAMIBIA MINE WORKERS - DISTRICTS

Indicators	Population sizes	General Incidence/ 100,000	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimatednumber of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)	TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases
OPUWO	7657	561	443	3,8%	32
OSHAKATI	36541	561	443	3,8%	153
OTJIWARONGO	28249	561	443	3,8%	118
OUTAPI	6437	561	443	3,8%	27
OUTJO	8445	561	443	3,8%	35
REHOBOTH	28843	561	443	3,8%	121
RUNDU	63431	561	443	3,8%	266
SWAKOPMUND	44724	561	443	3,8%	187
TSUMEB	19275	561	443	3,8%	81
USAKOS	3583	561	443	3,8%	15
WALVIS BAY	62096	561	443	3,8%	260
WINDHOEK	325858	720	571,68	3,8%	1364

TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases	MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB , N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)
39	**1**	**90%**	**44%**	**84%**
10	0	90%	44%	84%
0	0	90%	44%	84%
5	0	90%	44%	84%
0	0	90%	44%	84%
3	0	90%	44%	84%
1	0	90%	44%	84%
0	0	90%	44%	84%
0	0	90%	44%	84%
0	0	90%	44%	84%
0	0	90%	44%	84%
4	0	90%	44%	84%
5	0	90%	44%	84%
11	0	90%	44%	84%

MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB , N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)
1	90%	44%	84%
6	90%	44%	84%
4	90%	44%	84%
1	90%	44%	84%
1	90%	44%	84%
5	90%	44%	84%
10	90%	44%	84%
7	90%	44%	84%
3	90%	44%	84%
1	90%	44%	84%
10	90%	44%	84%
52	90%	44%	84%

TABLE A4.9: NAMIBIA GENERAL POPULATION - DISTRICTS

Indicators	Population sizes	General Incidence/ 100,000	TB Incidence rate in miners/100,000	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimated number of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)
Population of miners	19000	561	746	592	3,8%
Erongo	5004	263	350	278	3,8%
Hardap	81	288	383	304	3,8%
IKaras	2263	325	432	343	3,8%
Kavango	54	182	242	192	3,8%
Khomas	1368	179	238	189	3,8%
Kunene	314	119	158	126	3,8%
Ohangwena		170	226	180	3,8%
Omaheke	27	181	241	191	3,8%
Omusati	128	110	146	116	3,8%
Oshana	178	186	247	196	3,8%
Oshikoto	1832	151	201	159	3,8%
Otjozondjupa	2310	222	295	234	3,8%
Others	5441	561	746	592	3,8%

Indicators	Population sizes	General Incidence/ 100,000	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimated number of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)	TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases
DISTRICT					
Aranos	3683	561	443	3,8%	15
Eenhana	5528	561	443	3,8%	23
Gobabis	19101	561	443	3,8%	80
Grootfotein	33860	561	443	3,8%	142
Karasburg	4401	561	443	3,8%	18
Katima Mulilo	28862	561	443	3,8%	121
Keetmanshoop	20977	561	443	3,8%	88
Khorixas	6796	561	443	3,8%	28
Luderits	12537	561	443	3,8%	52
Mariental	12478	561	443	3,8%	52
Okahandja	22639	561	443	3,8%	95
Okahao	1665	561	443	3,8%	7
Okarara	4709	561	443	3,8%	20
Omaruru	6300	561	443	3,8%	26
Opuwo	7657	561	443	3,8%	32
Oshakati	36541	561	443	3,8%	153
Otjiwarongo	28249	561	443	3,8%	118
Outapi	6437	561	443	3,8%	27
Outjo	8445	561	443	3,8%	35
Rehoboth	28843	561	443	3,8%	121
Rundu	63431	561	443	3,8%	266
Swakopmund	44724	561	443	3,8%	187
Tsumeb	19275	561	443	3,8%	81
Usakos	3583	561	443	3,8%	15
Walvis Bay	62096	561	443	3,8%	260
Windhoek	325858	720	571,68	3,8%	1364

TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases	MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB , N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)
39	1	90%	44%	84%
10	0	90%	44%	84%
0	0	90%	44%	84%
5	0	90%	44%	84%
0	0	90%	44%	84%
3	0	90%	44%	84%
1	0	90%	44%	84%
0	0	90%	44%	84%
0	0	90%	44%	84%
0	0	90%	44%	84%
0	0	90%	44%	84%
4	0	90%	44%	84%
5	0	90%	44%	84%
11	0	90%	44%	84%

MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB , N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)
1	90%	44%	84%
1	90%	44%	84%
2	90%	44%	84%
5	90%	44%	84%
1	90%	44%	84%
5	90%	44%	84%
2	90%	44%	84%
1	90%	44%	84%
2	90%	44%	84%
2	90%	44%	84%
4	90%	44%	84%
0	90%	44%	84%
1	90%	44%	84%
1	90%	44%	84%
1	90%	44%	84%
6	90%	44%	84%
4	90%	44%	84%
1	90%	44%	84%
1	90%	44%	84%
5	90%	44%	84%
10	90%	44%	84%
7	90%	44%	84%
2	90%	44%	84%
1	90%	44%	84%
10	90%	44%	84%
52	90%	44%	84%

South Africa

TABLE A5.10: SOUTH AFRICA GENERAL POPULATION

Indicators	Population sizes	General Incidence/ 100,000	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimated number of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)	TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases
South Africa	54 956 900	834	776	2,1%	31 8193
PROVINCE					
The Eastern Cape	6916200	792	737	1,7%	54 797
The Free State	2817900	638	593	1,8%	17 967
Gauteng	13200300	362	336	2,7%	47 732
KwaZulu-Natal	10919100	864	804	1,8%	94 385
Limpopo	5726800	311	289	1,4%	17 793
Mpumalanga	4283900	450	419	4,2%	19 278
The Northern Cape	1185600	768	714	1,3%	9 101
North West	3707000	569	529	1,9%	21 085
Western Cape	6200100	711	661	2,0%	44 058
DISTRICT					
A Nzo	828 711	599	557	1,7%	4 964
Amathole	896 875	651	605	1,7%	5 839
Buffalo City	757 267	823	765	1,7%	6 232
C Hani	804 765	708	658	1,7%	5 698
Joe Gqabi	354 819	675	628	1,7%	2 395
N Mandela Bay	1 184 988	1009	938	1,7%	11 957
OR Tambo	1 366 244	764	711	1,7%	10 438
S Baartman	461 989	1127	1048	1,7%	5 207
Fezile Dabi	513 092	514	478	1,8%	2 637
Lejweleputswa	603 136	754	701	1,8%	4 548
Mangaung	783 580	686	638	1,8%	5 375
T Mofutsanyana	718 549	511	475	1,8%	3 672
Xhariep	139 567	969	901	1,8%	1 352
Ekurhuleni	3 284 630	317	295	2,7%	10 412
Johannesburg	4 763 168	363	338	2,7%	17 290
Sedibeng	922 050	476	443	2,7%	4 389
Tshwane	3 165 745	351	326	2,7%	11 112
West Rand	860 613	440	409	2,7%	3 787
Amajuba	514 977	541	503	1,8%	2 786
eThekwini	3 492 345	916	852	1,8%	31 990
Harry Gwala	478 535	833	775	1,8%	3 986
iLembe	640 790	874	813	1,8%	5 601
Ugu	741 541	1044	971	1,8%	7 742
uMgungundlovu	1 069 657	1097	1020	1,8%	11 734
uMkhanyakude	643 760	713	663	1,8%	4 590
uMzinyathi	518 409	634	590	1,8%	3 287

MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB, N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)
6682	93%	61%	79%
932	93%	Soutj	79%
323	93%	61%	79%
1289	93%	61%	79%
1699	93%	61%	79%
249	93%	61%	79%
810	93%	61%	79%
118	93%	61%	79%
401	93%	61%	79%
881	93%	61%	79%
84	93%	61%	79%
99	93%	61%	79%
106	93%	61%	79%
97	93%	61%	79%
41	93%	61%	79%
203	93%	61%	79%
177	93%	61%	79%
89	93%	61%	79%
47	93%	61%	79%
82	93%	61%	79%
97	93%	61%	79%
66	93%	61%	79%
24	93%	61%	79%
281	93%	61%	79%
467	93%	61%	79%
119	93%	61%	79%
300	93%	61%	79%
102	93%	61%	79%
50	93%	61%	79%
576	93%	61%	79%
72	93%	61%	79%
101	93%	61%	79%
139	93%	61%	79%
211	93%	61%	79%
83	93%	61%	79%
59	93%	61%	79%

uThukela	689 122	646	601	1,8%	4 452
uThungulu	947 926	888	826	1,8%	8 418
Zululand	834 251	801	745	1,8%	6 682
Capricorn	1 274 861	305	284	1,4%	3 888
Mopani	1 118 933	328	305	1,4%	3 670
Sekhukhune	1 122 522	264	246	1,4%	2 963
Vhembe	1 347 235	238	221	1,4%	3 206
Waterberg	721 684	502	467	1,4%	3 623
Ehlanzeni	1 732 786	523	486	4,2%	9 062
G Sibande	1 066 395	455	423	4,2%	4 852
Nkangala	1 382 414	355	330	4,2%	4 908
Frances Baard	380 807	649	604	1,3%	2 471
JT Gaetsewe	234 524	688	640	1,3%	1 614
Namakwa	118 673	559	520	1,3%	663
Pixley ka Seme	191 078	962	895	1,3%	1 838
ZF Mgcawu	247 542	976	908	1,3%	2 416
Bojanala	1 598 315	466	433	1,9%	7 448
Dr K Kaunda	716 277	696	647	1,9%	4 985
NM Molema	860 638	557	518	1,9%	4 794
RS Mompati	474 430	742	690	1,9%	3 520
Cape Town	3 929 343	642	597	2,0%	25 226
Cape Winelands	826 440	883	821	2,0%	7 297
Central Karoo	722 267	843	784	2,0%	6 089
Eden	595 541	806	750	2,0%	4 800
Overberg	279 189	749	697	2,0%	2 091
West Coast	428 011	827	769	2,0%	3 540

80	93%	61%	79%
152	93%	61%	79%
120	93%	61%	79%
54	93%	61%	79%
51	93%	61%	79%
41	93%	61%	79%
45	93%	61%	79%
51	93%	61%	79%
381	93%	61%	79%
204	93%	61%	79%
206	93%	61%	79%
32	93%	61%	79%
21	93%	61%	79%
9	93%	61%	79%
24	93%	61%	79%
31	93%	61%	79%
142	93%	61%	79%
95	93%	61%	79%
91	93%	61%	79%
67	93%	61%	79%
505	93%	61%	79%
146	93%	61%	79%
122	93%	61%	79%
96	93%	61%	79%
42	93%	61%	79%
71	93%	61%	79%

South Africa

TABLE A5.11: SOUTH AFRICA MINEWORKERS

Indicators	Population sizes	General TB Incidence in miners	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimated number of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)	TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases
South Africa	493 921	1109	1032	2,1%	5 479
PROVINCE					
The Eastern Cape	1 311	1054	980	1,7%	14
The Free State	44 080	848	789	1,8%	374
Gauteng	70 699	481	447	2,7%	340
KwaZulu-Natal	10 857	1150	1069	1,8%	125
Limpopo	80 943	413	384	1,4%	334
Mpumalanga	88 045	599	557	4,2%	527
The Northern Cape	36 736	1021	949	1,3%	375
North West	157 986	757	704	1,9%	1 195
Western Cape	3 264	945	879	2,0%	31
DISTRICT					
A Nzo	21	797	741	1,7%	0
Amathole	79	866	805	1,7%	1
Buffalo City	136	1095	1018	1,7%	1
C Hani	143	942	876	1,7%	1
Joe Gqabi	25	898	835	1,7%	0
N Mandela Bay	377	1342	1248	1,7%	5
OR Tambo	342	1016	945	1,7%	3
S Baartman	188	1499	1394	1,7%	3
Fezile Dabi	11295	684	636	1,8%	77
Lejweleputswa	31933	1003	933	1,8%	320
Mangaung	84	912	849	1,8%	1
T Mofutsanyana	91	680	632	1,8%	1
Xhariep	677	1289	1199	1,8%	9
Ekurhuleni	2923	422	392	2,7%	12
Johannesburg	7417	483	449	2,7%	36
Sedibeng	275	633	589	2,7%	2
Tshwane	3377	467	434	2,7%	16
West Rand	56707	585	544	2,7%	332
Amajuba	1812	720	669	1,8%	13
eThekwini	317	1218	1133	1,8%	4
Harry Gwala	108	1108	1030	1,8%	1
iLembe	139	1162	1081	1,8%	2
Ugu	480	1389	1291	1,8%	7
uMgungundlovu	181	1459	1357	1,8%	3
uMkhanyakude	1414	948	882	1,8%	13
uMzinyathi	489	843	784	1,8%	4

MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB, N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)
115	93%	61%	79%
0	93%	61%	79%
7	93%	61%	79%
9	93%	61%	79%
2	93%	61%	79%
5	93%	61%	79%
22	93%	61%	79%
5	93%	61%	79%
23	93%	61%	79%
1	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
1	93%	61%	79%
6	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
1	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
9	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%

uThukela	80	859	799	1,8%	1
uThungulu	4 083	1 181	1 098	1,8%	48
Zululand	1 754	1 065	991	1,8%	19
Capricorn	1 062	406	377	1,4%	4
Mopani	8 420	436	406	1,4%	37
Sekhukhune	33 798	351	327	1,4%	119
Vhembe	4 182	317	294	1,4%	13
Waterberg	33 481	668	621	1,4%	224
Ehlanzeni	5 584	696	647	4,2%	39
G Sibande	28 023	605	563	4,2%	170
Nkangala	54 438	472	439	4,2%	257
Frances Baard	3 106	863	803	1,3%	27
JT Gaetsewe	22 013	915	851	1,3%	201
Namakwa	2 730	743	691	1,3%	20
Pixley ka Seme	2 337	1 279	1 190	1,3%	30
ZF Mgcawu	6 550	1 298	1 207	1,3%	85
Bojanala	144 434	620	576	1,9%	895
Dr K Kaunda	12 239	926	861	1,9%	113
NM Molema	985	741	689	1,9%	7
RS Mompati	328	987	918	1,9%	3
Cape Town	490	854	794	2,0%	4
Cape Winelands	208	1 174	1 092	2,0%	2
Central Karoo	0	1 121	1 043	2,0%	0
Eden	473	1 072	997	2,0%	5
Overberg	159	996	926	2,0%	2
West Coast	1 934	1 100	1 023	2,0%	21

0	93%	61%	79%
1	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
1	93%	61%	79%
2	93%	61%	79%
0	93%	61%	79%
3	93%	61%	79%
2	93%	61%	79%
7	93%	61%	79%
11	93%	61%	79%
0	93%	61%	79%
3	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
1	93%	61%	79%
17	93%	61%	79%
2	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%
0	93%	61%	79%

Swaziland

TABLE A5. 12: SWAZILAND GENERAL POPULATION

Indicators	Population sizes	General Incidence	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimated number of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)	TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases
General Population	1 300 000	733	638	7,7%	5 616
Hhohho	360 896	652	567	7,7%	1 559
Manzini	407 864	908	790	7,7%	1 762
Lubombo	265 159	613	533	7,7%	1 145
Shiselweni	266 082	613	533	7,7%	1 149

TABLE A5.13: SWAZILAND MINEWORKERS

Indicators	Population sizes	General Incidence	TB Incidence rate in miners/100,000	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimatednumber of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)
Population of miners	2 520	733	975	848	7,7%
Hhohho	403	651,9	867	754	7,7%
Manzini	540	908,3	1 208	1 051	7,7%
Lubombo	1 030	612,5	815	709	7,7%
Shiselweni	547	612,5	815	709	7,7%

MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB, N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)
320	97%	79%
89	97%	79%
100	97%	79%
65	97%	79%
65	97%	79%

TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases	MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB), N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)
25	2	97%	79%
3	0	97%	79%
7	0	97%	79%
8	1	97%	79%
4	0	97%	79%

Tanzania

TABLE A5.14: TANZANIA GENERAL POPULATION

Indicators	Population sizes	General TB Incidence in miners	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimated number of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)	TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases
General Population	54 308 045	327	314	1,1%	63 151
Geita	807 619	327	314	1,1%	1 444
Simanjiro	178 693	327	314	1,1%	320
Arusha	281 608	327	314	1,1%	504
Kahama	594 891	327	314	1,1%	1 064
Tarime	490 731	327	314	1,1%	878
Butiama District	241 732	327	314	1,1%	432
Arumeru	514 651	327	314	1,1%	920
Babati	302 253	327	314	1,1%	541
Bagamoyo	228 967	327	314	1,1%	409
Bariadi	603 604	327	314	1,1%	1 079
Biharamulo	409 389	327	314	1,1%	732
Bukoba Rural	394 020	327	314	1,1%	705
Bukoba Urban	80 868	327	314	1,1%	145
Bukombe	395 298	327	314	1,1%	707
Bunda	258 930	327	314	1,1%	463
Chake	82 998	327	314	1,1%	148
Chunya	205 915	327	314	1,1%	368
Dodoma Rural	438 866	327	314	1,1%	785
Dodoma Urban	322 811	327	314	1,1%	577
Hai	258 935	327	314	1,1%	463
Hanang	204 640	327	314	1,1%	366
Handeni	248 633	327	314	1,1%	445
Igunga	324 094	327	314	1,1%	580
Ilala	634 924	327	314	1,1%	1 135
Ileje	109 847	327	314	1,1%	196
Ilemela	264 873	327	314	1,1%	474
Iramba	367 036	327	314	1,1%	656
Iringa Urban	106 371	327	314	1,1%	190
Karagwe	424 287	327	314	1,1%	759
Karatu	177 951	327	314	1,1%	318
Kaskazini 'A'	84 147	327	314	1,1%	150
Kaskazini 'B'	52 492	327	314	1,1%	94
Kasulu	626 742	327	314	1,1%	1121
Kati	62 391	327	314	1,1%	112
Kibaha	131 242	327	314	1,1%	235
Kibondo	413 777	327	314	1,1%	740
Kigoma Rural	489 271	327	314	1,1%	875

MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB, N=Cases	TB/HIV-1: Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)
516	91%	35%	83%
16	91%	35%	83%
4	91%	35%	83%
6	91%	35%	83%
12	91%	35%	83%
10	91%	35%	83%
5	91%	35%	83%
10	91%	35%	83%
6	91%	35%	83%
5	91%	35%	83%
12	91%	35%	83%
8	91%	35%	83%
8	91%	35%	83%
2	91%	35%	83%
8	91%	35%	83%
5	91%	35%	83%
2	91%	35%	83%
4	91%	35%	83%
9	91%	35%	83%
6	91%	35%	83%
5	91%	35%	83%
4	91%	35%	83%
5	91%	35%	83%
6	91%	35%	83%
12	91%	35%	83%
2	91%	35%	83%
5	91%	35%	83%
7	91%	35%	83%
2	91%	35%	83%
8	91%	35%	83%
4	91%	35%	83%
2	91%	35%	83%
1	91%	35%	83%
12	91%	35%	83%
1	91%	35%	83%
3	91%	35%	83%
8	91%	35%	83%
10	91%	35%	83%

Kigoma Urban	144 257	327	314	1,1%	258
Kilindi	143 792	327	314	1,1%	257
Kilolo	204 372	327	314	1,1%	365
Kilombero	321 611	327	314	1,1%	575
Kilosa	488 191	327	314	1,1%	873
Kilwa	171 057	327	314	1,1%	306
Kinondoni	1 083 913	327	314	1,1%	1938
Kisarawe	95 323	327	314	1,1%	170
Kishapu	239 305	327	314	1,1%	428
Kiteto	152 296	327	314	1,1%	272
Kondoa	428 090	327	314	1,1%	766
Kongwa	248 656	327	314	1,1%	445
Korogwe	260 238	327	314	1,1%	465
Kusini	31 853	327	314	1,1%	57
Kwimba	314 925	327	314	1,1%	563
Kyela	173 830	327	314	1,1%	311
Lindi Rural	214 882	327	314	1,1%	384
Lindi Urban	41 075	327	314	1,1%	73
Liwale	75 128	327	314	1,1%	134
Ludewa	128 155	327	314	1,1%	229
Lushoto	418 652	327	314	1,1%	749
Mafia	40 557	327	314	1,1%	73
Magharibi	184 204	327	314	1,1%	329
Magu	415 005	327	314	1,1%	742
Masasi	440 987	327	314	1,1%	789
Maswa	304 402	327	314	1,1%	544
Mbarali	234 101	327	314	1,1%	419
Mbeya Rural	254 069	327	314	1,1%	454
Mbeya Urban	265 586	327	314	1,1%	475
Mbinga	403 819	327	314	1,1%	722
Mbozi	513 600	327	314	1,1%	919
Mbulu	237 280	327	314	1,1%	424
Meatu	248 214	327	314	1,1%	444
Micheweni	83 266	327	314	1,1%	149
Misungwi	256 133	327	314	1,1%	458
Mjini	205 870	327	314	1,1%	368
Mkoani	92 473	327	314	1,1%	165
Mkuranga	186 927	327	314	1,1%	334
Monduli	184 516	327	314	1,1%	330
Morogoro Rural	263 012	327	314	1,1%	470
Morogoro Urban	227 921	327	314	1,1%	408
Moshi Rural	401 369	327	314	1,1%	718
Moshi Urban	143 799	327	314	1,1%	257
Mpanda	410 452	327	314	1,1%	734
Mpwapwa	253 602	327	314	1,1%	454
Mtwara Rural	204 157	327	314	1,1%	365
Mtwara Urban	92 156	327	314	1,1%	165

3	91%	35%	83%
3	91%	35%	83%
4	91%	35%	83%
6	91%	35%	83%
10	91%	35%	83%
3	91%	35%	83%
21	91%	35%	83%
2	91%	35%	83%
5	91%	35%	83%
3	91%	35%	83%
8	91%	35%	83%
5	91%	35%	83%
5	91%	35%	83%
1	91%	35%	83%
6	91%	35%	83%
3	91%	35%	83%
4	91%	35%	83%
1	91%	35%	83%
1	91%	35%	83%
3	91%	35%	83%
8	91%	35%	83%
1	91%	35%	83%
4	91%	35%	83%
8	91%	35%	83%
9	91%	35%	83%
6	91%	35%	83%
5	91%	35%	83%
5	91%	35%	83%
5	91%	35%	83%
8	91%	35%	83%
10	91%	35%	83%
5	91%	35%	83%
5	91%	35%	83%
2	91%	35%	83%
5	91%	35%	83%
4	91%	35%	83%
2	91%	35%	83%
4	91%	35%	83%
4	91%	35%	83%
5	91%	35%	83%
4	91%	35%	83%
8	91%	35%	83%
3	91%	35%	83%
8	91%	35%	83%
5	91%	35%	83%
4	91%	35%	83%
2	91%	35%	83%

Mufindi	282 071	327	314	1,1%	504
Muheza	278 405	327	314	1,1%	498
Muleba	385 184	327	314	1,1%	689
Musoma Rural	329 824	327	314	1,1%	590
Musoma Urban	107 855	327	314	1,1%	193
Mvomero	259 347	327	314	1,1%	464
Mwanga	115 145	327	314	1,1%	206
Nachingwea	161 473	327	314	1,1%	289
Namtumbo	175 051	327	314	1,1%	313
Newala	183 344	327	314	1,1%	328
Ngara	334 409	327	314	1,1%	598
Ngorongoro	129 362	327	314	1,1%	231
Njombe	419 115	327	314	1,1%	750
Nkasi	207 311	327	314	1,1%	371
Nyamagana	209 806	327	314	1,1%	375
Nzega	415 203	327	314	1,1%	743
Pangani	43 920	327	314	1,1%	79
Rombo	245 716	327	314	1,1%	439
Rungwe	306 380	327	314	1,1%	548
Same	211 738	327	314	1,1%	379
Sengerema	498 993	327	314	1,1%	892
Serengeti	176 057	327	314	1,1%	315
Shinyanga Rural	276 393	327	314	1,1%	494
Shinyanga Urban	134 523	327	314	1,1%	241
Sikonge	132 733	327	314	1,1%	237
Singida Rural	400 377	327	314	1,1%	716
Singida Urban	114 853	327	314	1,1%	205
Songea Rural	156 930	327	314	1,1%	281
Songea Urban	130 860	327	314	1,1%	234
Sumbawanga Rural	371 749	327	314	1,1%	665
Sumbawanga Urban	146 842	327	314	1,1%	263
Tabora Urban	188 005	327	314	1,1%	336
Tandahimba	203 837	327	314	1,1%	365
Tanga	242 640	327	314	1,1%	434
Tarime	490 731	327	314	1,1%	878
Temeke	768 451	327	314	1,1%	1374
Tunduru	247 055	327	314	1,1%	442
Ukerewe	260 831	327	314	1,1%	466
Ulanga	193 280	327	314	1,1%	346
Urambo	369 329	327	314	1,1%	660
Uyui	281 101	327	314	1,1%	503
Wete	102 060	327	314	1,1%	183

6	91%	35%	83%
5	91%	35%	83%
8	91%	35%	83%
6	91%	35%	83%
2	91%	35%	83%
5	91%	35%	83%
2	91%	35%	83%
3	91%	35%	83%
3	91%	35%	83%
4	91%	35%	83%
7	91%	35%	83%
3	91%	35%	83%
8	91%	35%	83%
4	91%	35%	83%
4	91%	35%	83%
8	91%	35%	83%
1	91%	35%	83%
5	91%	35%	83%
6	91%	35%	83%
4	91%	35%	83%
10	91%	35%	83%
3	91%	35%	83%
5	91%	35%	83%
3	91%	35%	83%
3	91%	35%	83%
8	91%	35%	83%
2	91%	35%	83%
3	91%	35%	83%
3	91%	35%	83%
7	91%	35%	83%
3	91%	35%	83%
4	91%	35%	83%
4	91%	35%	83%
5	91%	35%	83%
10	91%	35%	83%
15	91%	35%	83%
5	91%	35%	83%
5	91%	35%	83%
4	91%	35%	83%
7	91%	35%	83%
6	91%	35%	83%
2	91%	35%	83%

TABLE A4.15: TANZANIA MINEWORKERS

Indicators	Population sizes	General Incidence /100,000	TB Incidence rate in miners/100,000	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimatednumber of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)
Population of miners	1500000	327	435	413	1,1%

TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases	MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/ or MDR-TB), N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)
6524	72	91%	35%	83%

Zambia

TABLE A5.16: ZAMBIA GENERAL POPULATION

Indicators	Population sizes	General Incidence	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimatednumber of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)	TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases
General Population	16 000 000	406	345	0,3%	42 716
Chadiza-Eastern Province	124 504	406	345	0,3%	332
Chama-Muchinga Province	137 186	406	345	0,3%	366
Chibombo	355 138	406	345	0,3%	948
Chiengi	137 692	406	345	0,3%	368
Chilanga	107 051	406	345	0,3%	286
Chililabombwe	118 041	406	345	0,3%	315
Chilubi	91 780	406	345	0,3%	245
Chingola	266 478	406	345	0,3%	711
Chinsali -Muchinga Province	172 217	406	345	0,3%	460
Chipata-Eastern Province	519 511	406	345	0,3%	1 387
Chonggwe	236 749	406	345	0,3%	632
Isoka-Muchinga Province	90 259	406	345	0,3%	241
Itezhi-Tezhi	91 352	406	345	0,3%	244
Kabompo	111 036	406	345	0,3%	296
Kabwe	224 307	406	345	0,3%	599
Kafue	293 149	406	345	0,3%	783
Kalomo	335 539	406	345	0,3%	896
Kalulushi	127 080	406	345	0,3%	339
Kaoma	209 369	406	345	0,3%	559
Kapiri Mposhi	303 263	406	345	0,3%	810
Kaputa	145 489	406	345	0,3%	388
Kasama	280 500	406	345	0,3%	749
Katete Eastern Province	284 172	406	345	0,3%	759
Kawambwa	134 414	406	345	0,3%	359
Kitwe	668 668	406	345	0,3%	1 785
Livingston	169 237	406	345	0,3%	452
Luangwa	28 477	406	345	0,3%	76
Luanshya	173 335	406	345	0,3%	463
Lufwanyama	95 384	406	345	0,3%	255
Lukulu	99 391	406	345	0,3%	265
Lundazi-Eastern Province	390 314	406	345	0,3%	1 042
Lusaka	2 330 200	406	345	0,3%	6 221
Mabote	49 867	406	345	0,3%	133

MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB , N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)	HIV prevalence (%)
83	93%	61%	73%	13,5%
1	93%	61%	73%	
1	93%	61%	73%	
2	93%	61%	73%	
1	93%	61%	73%	
1	93%	61%	73%	19,8%
1	93%	61%	73%	16%
0	93%	61%	73%	
1	93%	61%	73%	25,5%
1	93%	61%	73%	
3	93%	61%	73%	
1	93%	61%	73%	
0	93%	61%	73%	
0	93%	61%	73%	
1	93%	61%	73%	
1	93%	61%	73%	
2	93%	61%	73%	
2	93%	61%	73%	
1	93%	61%	73%	16%
1	93%	61%	73%	8,3%
2	93%	61%	73%	
1	93%	61%	73%	
1	93%	61%	73%	
1	93%	61%	73%	
1	93%	61%	73%	7,1%
3	93%	61%	73%	22,5%
1	93%	61%	73%	
0	93%	61%	73%	
1	93%	61%	73%	
0	93%	61%	73%	9,6%
1	93%	61%	73%	8,3%
2	93%	61%	73%	
12	93%	61%	73%	
0	93%	61%	73%	

Mafinga-Muchinga Province	93 327	406	345	0,3%	249
Mbala	245 928	406	345	0,3%	657
Mufulira	188 444	406	345	0,3%	503
Mambwe-Eastern Province	86 059	406	345	0,3%	230
Mansa	263 584	406	345	0,3%	704
Masaiti	117 393	406	345	0,3%	313
Milenge	56 618	406	345	0,3%	151
Mkushi	195 247	406	345	0,3%	521
Mpika-Muchinga Province	286 979	406	345	0,3%	766
Mpongwe	124 482	406	345	0,3%	332
Mufulira	188 444	406	345	0,3%	503
Mumbwa	284 012	406	345	0,3%	758
Mwense	129 922	406	345	0,3%	347
Nakonde-Muchinga Province	170 700	406	345	0,3%	456
Nchelenge	185 146	406	345	0,3%	494
Ndola	540 923	406	345	0,3%	1444
Nyimba-Eastern Province	95 464	406	345	0,3%	255
Petauke-Eastern Province	361 467	406	345	0,3%	965
Samfya	224 666	406	345	0,3%	600
Serenje	195 007	406	345	0,3%	521
Solwezi	299 725	406	345	0,3%	800
Zambezi	94 023	406	345	0,3%	251
Others	2 671 291	406	345	0,3%	7132

TABLE A5.17: ZAMBIA MINE WORKERS

Indicators	Population sizes	General Incidence /100,000	TB Incidence rate in miners/100,000	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimatednumber of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)
Population of miners	68 473	406	540	459	0,03%

0	93%	61%	73%	
1	93%	61%	73%	
1	93%	61%	73%	16%
0	93%	61%	73%	
1	93%	61%	73%	10%
1	93%	61%	73%	9,6
0	93%	61%	73%	7,1%
1	93%	61%	73%	
1	93%	61%	73%	
1	93%	61%	73%	9,6%
1	93%	61%	73%	
1	93%	61%	73%	
1	93%	61%	73%	7,1%
1	93%	61%	73%	
1	93%	61%	73%	8,5%
3	93%	61%	73%	22,5%
0	93%	61%	73%	
2	93%	61%	73%	
1	93%	61%	73%	8,4%
1	93%	61%	73%	
2	93%	61%	73%	
0	93%	61%	73%	
14	93%	61%	73%	

TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases	MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/ or MDR-TB), N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)
370	1	93%	61%	73%

Zimbabwe

TABLE A5.18: ZIMBABWE GENERAL POPULATION

Indicators	Population sizes	General Incidence	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimatednumber of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)	TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases
General Population	**15 000 000**	**603**	**531**	**2,2%**	**32016**
PROVINCE					
Bulawayo	750 316	603	531	2,2%	1 601
Harare	2 438 282	603	531	2,2%	5 204
Manicaland	2 012 862	603	531	2,2%	4 296
Mashonaland Central	1 323 596	603	531		2 825
Mashonaland East	1 544 595	603	531	2,2%	3 297
Mashonaland West	1 724 556	603	531	2,2%	3 681
Masvingo	1 705 531	603	531	2,2%	3 640
Matabeleland North	860 198	603	531	2,2%	1 836
Matabeleland South	785 407	603	531	2,2%	1 676
Midlands	1 854 657	603	531	2,2%	3 959
DISTRICT					
Beitbridge	41 767	603	531	2,2%	89
Bikita	162 356	603	531	2,2%	347
Bindura	43 675	603	531	2,2%	93
Bubi	61 883	603	531	2,2%	132
Bulawayo	653 337	603	531	2,2%	1 394
Chegutu	50 255	603	531	2,2%	107
Chimanimani	134 940	603	531	2,2%	288
Chinhoyi	68 273	603	531	2,2%	146
Chipinge	25 214	603	531	2,2%	54
Chiredzi	275 759	603	531	2,2%	589
Chivi	166 049	603	531	2,2%	354
Epworth	167 462	603	531	2,2%	357
Gokwe	23 906	603	531	2,2%	51
Guruve	124 041	603	531	2,2%	265
Gutu	203 083	603	531	2,2%	433
Gwanda	19 895	603	531	2,2%	42
Gweru	154 825	603	531	2,2%	330
Harare	1 485 231	603	531	2,2%	3 170
Hwange	19 870	603	531	2,2%	42
Kadoma	91 633	603	531	2,2%	196
Kariba	26 112	603	531	2,2%	56
Karoi	26 009	603	531	2,2%	56
Kwekwe	100 900	603	531	2,2%	215
Lupane	2 211	603	531	2,2%	5
Makoni	272 340	603	531	2,2%	581
Marondera	272 340	603	531	2,2%	132
Mashava mine	5 859	603	531	2,2%	13
Masvingo	87 886	603	531	2,2%	188
Mazowe	233 450	603	531	2,2%	498

MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB , N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)	HIV prevalence (%)	HIV Prevalence in adults(15-49 years) (%)
540	**89%**	**68%**	**86%**	**9,3%**	**14,7%**
27	89%	68%	86%	9,3%	19,0%
88	89%	68%	86%	9,3%	13,0%
72	89%	68%	86%	9,3%	14,0%
48	89%	68%	86%	9,3%	14,0%
56	89%	68%	86%	9,3%	16,0%
62	89%	68%	86%	9,3%	15,0%
61	89%	68%	86%	9,3%	14,0%
31	89%	68%	86%	9,3%	18,0%
28	89%	68%	86%	9,3%	21,0%
67	89%	68%	86%	9,3%	15,0%
2	89%	68%	86%		
8	89%	68%	86%		
2	89%	68%	86%		
3	89%	68%	86%		
31	89%	68%	86%		
2	89%	68%	86%		
6	89%	68%	86%		
3	89%	68%	86%		
1	89%	68%	86%		
13	89%	68%	86%		
8	89%	68%	86%		
8	89%	68%	86%		
1	89%	68%	86%		
6	89%	68%	86%		
10	89%	68%	86%		
1	89%	68%	86%		
7	89%	68%	86%		
70	89%	68%	86%		
1	89%	68%	86%		
4	89%	68%	86%		
1	89%	68%	86%		
1	89%	68%	86%		
5	89%	68%	86%		
0	89%	68%	86%		
13	89%	68%	86%		
3	89%	68%	86%		
0	89%	68%	86%		
4	89%	68%	86%		
11	89%	68%	86%		

TABLE A5.19: ZIMBABWE MINEWORKERS

Indicators	Population sizes	General Incidence /100,000	TB O-1a: Case notification rate of new and relapse TB cases Bacteriological + Clinical (Rate/100,000)	TB O-3: Proportion of estimated number of drug resistant TB (RR-TB and MDR-TB) cases among notified TB cases (%)	TB-1: Number of notified cases of all forms of TB (bacteriologically confirmed+clinically diagnosed) N=cases
Mhangura mine	2 930	603	531	2,2%	6
Mutasa	168 747	603	531	2,2%	360
Mutare	186 208	603	531	2,2%	397
Mutoko	12 336	603	531	2,2%	26
Mvurwi	10 548	603	531	2,2%	23
Mwenezi	166 993	603	531	2,2%	356
Norton	67 591	603	531	2,2%	144
Plumtree	11 626	603	531	2,2%	25
Redcliff	35 904	603	531	2,2%	77
Rusape	30 316	603	531	2,2%	65
Ruwa	56 678	603	531	2,2%	121
Shamva	908	603	531	2,2%	2
Shurugwi	21 501	603	531	2,2%	46
Victoria falls	33 660	603	531	2,2%	72
Zaka	181 307	603	531	2,2%	387
Zvishavane	45 230	603	531	2,2%	97
Others*	9 239 181	603	531	2,2%	19 720

MDR TB-2: Number of bacteriologically confirmed drug resistant TB (RR-TB and/or MDR-TB), N=Cases	TB/HIV-1:Proportion of TB patients with known HIV status (%)	TB/HIV-2: Proportion of HIV-Positive TB patients (%)	TB/HIV-2: Proportion of HIV-Positive TB patients given ART during TB treatment (%)
0	89%	68%	86%
8	89%	68%	86%
9	89%	68%	86%
1	89%	68%	86%
0	89%	68%	86%
8	89%	68%	86%
3	89%	68%	86%
1	89%	68%	86%
2	89%	68%	86%
1	89%	68%	86%
3	89%	68%	86%
0	89%	68%	86%
1	89%	68%	86%
2	89%	68%	86%
9	89%	68%	86%
2	89%	68%	86%
434	89%	68%	86%


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