

AFRICA UNIVERSITY

(A United Methodist-Related University)

IMPACT OF SILICOSIS ON TUBERCULOSIS TREATMENT
OUTCOMES IN KWEKWE CITY, MIDLANDS PROVINCE,
ZIMBABWE, 2022 – 2024

BY

ZVICHAUYA MUVANGO

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF PUBLIC HEALTH IN THE
COLLEGE OF HEALTH, AGRICULTURE AND NATURAL SCIENCES

2025

Abstract

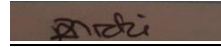
The co-existence of tuberculosis and silicosis may exacerbate treatment outcomes. Silicosis and tuberculosis are the diseases that have been targeted for elimination by 2030 globally. The study was aimed at determining the association of silicosis and unfavorable TB treatment outcomes in Kwekwe City. The study also aimed at exploring ways of improving treatment outcomes among silico-tuberculosis patients. A retrospective cohort was conducted among 165 male TB patients and 45 male silico TB patients admitted at Kwekwe General Hospital between 2022 and 2024 as well as 819 TB Patients and 11 silico -TB patients enrolled in Kwekwe City TB Registers between 2022 and 2024. The chi square test analysis was used to assess whether there is a statistically significant association between patients with silico-TB and having unfavorable treatment outcomes. This association was also assessed on TB patients without silicosis at 5% level of significance. In addition, Pearson's Chi Square test statistic was also analyzed to assess if there is an association between silicosis and death, treatment failure and loss to follow-up. The statistical analysis was performed using SPSS and Epi info. The study therefore showed a 72.1% treatment success rate among TB patients admitted at Kwekwe Hospital and 27.9% death rate. Silico-TB had a 48.9% treatment success rate and a 51.1% death rate. For the Kwekwe City Clinics TB registers, TB treatment success rate was 84.9%, 0.8% death rate and 5.9% lost to follow up. Silico-TB treatment success rate was 54.5%, death rate 185 and loss to follow up rate was 27.2%. Controlling silicosis might decrease TB mortality and treatment failure in Kwekwe. Silicosis has a negative impact on TB treatment outcomes and it should be acknowledged as a co-morbidity of TB that should be included as a key risk factor in differentiated TB care approach. All TB patients need to be screened for silicosis regularly and all Silicosis patients need to be screened for TB regularly and initiated on TB preventive medicines. There is need to intensify health education on TB and Silicosis prevention and control including the occupation exposures that affect artisanal mining community of Kwekwe. Outreach programs for diagnosis, treatment and care for artisanal miners at their work areas need to be intensified so as to diagnose and treat these conditions early before they are complicated.

Keywords: Silicosis; Silico-Tuberculosis; Tuberculosis; Treatment Outcomes; Co-morbidity

Declaration

I declare that this is my original work except where sources have been cited and acknowledged. The work has never been submitted, nor will it ever be submitted to another university for the award of a degree.

Zvichauya Muvango

A handwritten signature in black ink on a dark rectangular background.

Student's Full Name

Student's Signature (25/03/25)

Prof Eltony Mugomeri

A handwritten signature in black ink.

Main Supervisor's Name

Main Supervisor's Signature (25/03/25)

Copyright

No part of this dissertation may be reproduced, stored in any retrieval system or transmitted in any form or by any means for scholarly purposes without prior written permission of the author or of Africa University on behalf of the author.

Acknowledgements

I would like to acknowledge the support and technical guidance I received from my Academic Supervisor Prof E Mugomeri and My Field Supervisor Dr S Ngwenya in writing this dissertation. I would also like to acknowledge continued support from colleagues, friends and family.

Dedication

I dedicate this dissertation to God the Almighty, for all he has done for me and to all Public Health Practitioners, continue doing that which is right even when no one is watching in order to save lives. That is called INTEGRITY.

List of Acronyms and Abbreviations

TB	Tuberculosis
Silico-tb	Tuberculosis with Silicosis
WHO	World Health Organization
MoHCC	Ministry of Health and Child Care

Definition of key terms

Tuberculosis	is an infectious disease that most often affects the lungs and is caused by a bacterium called <i>Mycobacterium tuberculosis</i> .
Silico-tuberculosis	is tuberculosis caused by the infection of <i>Mycobacterium tuberculosis</i> in patients with silicosis which is caused by inhalation of silica dust particles.
Silicosis	is an occupational disease caused by the deposition of free crystalline silica particles in the lungs which can cause irreversible pulmonary fibrosis
Treatment Outcome	is the result of a treatment plan
Treatment success	are the sum of cured and treatment completed cases
Died	a patient who dies for any reason during the course of TB treatment
Lost to follow-up	is a patient whose treatment was interrupted for two consecutive months or more
Treatment failure	a patient who is sputum smear or culture positive at 5 months or later during treatment.
Not Evaluated	Patient for whom no treatment outcome was assigned

Contents

Abstract	iii
Declaration	iv
Copyright	v
Acknowledgements	vi
Dedication	vii
List of Acronyms and Abbreviations	viii
Definition of key terms	ix
List of Tables	xiv
List of Figures	xv
List of Appendices	xvi
CHAPTER 1 INTRODUCTION	1
1.1 Introduction	1
1.2 Background of the Study	2
1.2 Statement of the Problem	4
1.3 Research Objectives	5
1.4 Research Questions	6
1.5 Assumptions/Hypotheses	6
1.6 Significance of the Study	6
1.7 Delimitation of the Study	7
1.8 Limitation of the Study	7
CHAPTER 2 REVIEW OF RELATED LITERATURE	8
2.1 Introduction	8
2.2 Conceptual Framework	9
2.3 Relevance of the Conceptual Framework to the study	10

2.4 Epidemiology of Tuberculosis and silicosis	11
2.5 Human Exposure to Silica Dust	13
2.6 Human Exposure to Mycobacterium Tuberculosis.....	14
2.7 Association between Silicosis and Pulmonary Tuberculosis	16
2.8 Tuberculosis and Silicosis Interaction	17
2.9.1 Tuberculosis Treatment success rates	19
2.9.2 Treatment Success Rates for Silico-TB	20
2.10 Death rates	21
2.10.1 Silico-TB Death Rates	21
2.10.2 Tuberculosis Death Rates.....	22
2.11 Rate of loss to follow of tuberculosis and silico tuberculosis patients	24
2.11.1 Silico-TB and TB Patients loss to follow up	25
2.11.2 Factors Contributing to Loss to Follow Up	27
2.12 Impact of Silicosis on TB Treatment Outcomes	28
2.12.1 Health Complications of Silicosis.....	29
2.12.2 The negative impact of silicosis on TB treatment outcome.....	31
2.12.3 Impact of late TB Diagnosis in Silicosis Patients	32
2.12.4 Approaches to address the burden of TB and Silicosis.....	33
2.13 Gaps in literature.....	36
2.14 Conclusion	37
CHAPTER 3 METHODOLOGY	39
3.1 Introduction.....	39
3.2 The Research Design	40
3.3 Population and Sampling	41
3.3.1 Purposive Sampling	41

3.3.2 Convenience Sampling	42
3.4 Data Collection Instruments	42
3.4.1 Interview Guides	43
3.4.2 Document Checklist	43
3.5 Data Collection Procedure	44
3.6 Analysis and Organization of Data	44
3.7 Ethical Consideration	45
3.8 Summary	45
CHAPTER 4: DATA PRESENTATION AND ANALYSIS	47
4.1 Introduction	47
4.2 Data Presentation, Interpretation and Analysis	47
4.2.1 Demographics of participants	47
4.2.2. Targeted TB and Silicosis Outreach Screening by Kunda Nqobi’ TB	48
4.2.3. Kwekwe General Hospital Male Ward TB, Silicosis and Silico TB Admissions	49
4.2.4 Community TB Report by TB Focal Nurse	50
4.2.5 Kwekwe City Council TB Registers 2022 to 2024	50
4.3 Discussion and Interpretation	51
4.4 Summary	54
CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS	55
5.1 Introduction	55
5.2 Discussion	55
5.2.1 Death Rate Assessment	57
5.2.2 Treatment Success Outcomes	59
5.2.3 Loss to Follow-Up Rate	60

5.3 Conclusions	60
5.4 Implications	61
5.5 Recommendations	62
5.6 Suggestions for Further Research	64
LIST OF REFERENCES	65

List of Tables

Table 1: Demographics of participants	47
Table 2 : Kunda Nqobi TB Outreach Screening	49

List of Figures

Figure 1: KN-TB Artisanal Miners Outreach Screening Program 2022-2024	Error!
Bookmark not defined.	
Figure 2: Conceptual Framework	9
Figure 3: The Great Dyke Map	39
Figure 4: Study Design Schema of retrospective cohort study for predictors of mortality, treatment failure, treatment success and loss to follow up.	41
Figure 5: Kwekwe General Hospital TB, Silicosis, Silico TB Admissions.....	50
Figure 6: Kwekwe City Council Clinics TB Registers	51

List of Appendices

APPENDIX 1: Interview guide for in-depth interviews	79
APPENDIX 2: Checklist for records review	.81
APPENDIX 3: Consent Form	82
APPENDIX 4: Approval for Data Collection-----	83
APPENDIX 5: AUREC Approval-----	84

CHAPTER 1 INTRODUCTION

1.1 Introduction

While tuberculosis remains a major global issue, silicosis and its associated risk of tuberculosis are significant concerns in specific occupational settings. Addressing both conditions through targeted public health initiatives is crucial for improving health outcomes in affected populations. An increase in silicosis and silico-TB cases globally prompted the researcher to investigate the impact of silicosis on TB treatment outcomes in Kwekwe City. The study conducted was a retrospective cohort study focusing of TB and silico-TB patients admitted at Kwekwe General Hospital between 2022 and 2024 as well as TB and silico-TB patients enrolled in the Kwekwe City Clinics registers between 2022 and 2024.

According to unpublished reports during the KN-TB close out review meeting held in Kwekwe, Kwekwe District Silicosis Screening during outreach programs in 2022, 2023 and 2024 had a total of 475, 536 and 1386 respectively. While those diagnosed with silicosis were 41, 80, 291 respectively. Those diagnosed with TB were 13, 5 and 13. Those diagnosed with silico-tb were 5 in 2024. This shows that the number of silicosis patients is increasing gradually and the same people are now susceptible to tuberculosis due to their occupational exposures as well as weakened immune system.

The study focused on the treatment outcomes of the silico-TB and TB patients in the Kwekwe Context so as to ascertain the impact posed by silicosis on TB treatment

outcomes. It also focused on possible improvements in the TB program that could be implemented so as to prevent treatment fail rates from increasing.

1.2 Background of the Study

The World Health Organization (WHO) estimates that 10.6 million new cases of tuberculosis (TB) were reported globally in 2021. India, China, Indonesia, Pakistan, and Nigeria had the greatest prevalence rates and were responsible for a large share of the world's TB cases. Worldwide, the goal is to eradicate TB and silicosis by the year 2030 (Rupani, 2023).

While many diseases can be caused by exposure to crystalline silica dust, two of the most important occupational concerns in both low- and high-income countries are silicosis and tuberculosis associated with silica dust (TB) (Marcin, etal 2018). Inhalation of crystalline silica dust causes silicosis, a fibrotic lung disease. Workers in the mining industry are not alone in experiencing this. Experts' views on how to enhance treatment results among silico-tb patients are to be explored, and the study's overarching goal is to ascertain the effect of silicosis on TB treatment outcomes. *Mycobacterium tuberculosis* is prevalent in many countries and poses a concern to people with silicosis who may develop active pulmonary TB.

The Kunda Nqobi'TB (KNTB) project being implemented in Zimbabwe since 2020, tuberculosis treatment outcomes at a glance were, the treatment success rate was 77.3% in Matabeleland South Province, with a high mortality rate of 30%; in Masvingo, it was

27.3%. Thus, the purpose of this study is to examine how silicosis affects the success rate of TB treatments in Kwekwe City.

The prevalence of silicosis was 11.2% among Artisanal Small Scale Miners in 2021 (Paul and Chounou, 2022), whereas the burden of tuberculosis was 4%. These data were derived from an outreach program in Zimbabwe. Moyo et al. (2022) reports that small-scale miners in Zimbabwe continue to face a high incidence of TB (7%), silicosis (19%), and human immunodeficiency virus (HIV) (18%). A study conducted in India by Roy et al (2023) concluded that a patient with silicosis has a 2.8-2.9 times higher risk of developing pulmonary tuberculosis and 3.7 times that of extra pulmonary tuberculosis.

About two million people in Zimbabwe rely on the over 500,000 artisanal and small-scale miners (PACT, 2015). The bulk of Kwekwe's population is either directly or indirectly involved with small-scale artisanal mining; the town is well-known for its mining history. There has been an increase in silicosis and silico tuberculosis cases among males in Kwekwe as evidenced by health records as well as media reports. More than twenty people have succumbed to the deadly silicosis disease at Kwekwe General Hospital (Michael Magoronga, The Chronicle Newspaper, November 3, 2023). According to Kwekwe news bulletin article dated 3 November 2024, the devastating impact of silicosis continue to be felt in the mining town of Kwekwe amid reports that the disease has claimed 28 lives since January this year. The researcher therefore seeks to investigate the impact of silicosis on tuberculosis treatment outcomes in Kwekwe City given the increased number of silicosis cases in the City.

1.2 Statement of the Problem

According to statistics kept at Kwekwe General Hospital, there was a gradual increase in the number of silico tuberculosis and silicosis cases in Kwekwe. This showed co morbidity of tuberculosis and silicosis. The most affected individuals were the male artisanal miners. This was happening despite the fact that there are legal frameworks that guide occupational settings to prevent occupational diseases for example the Pneumoconiosis Act.

There was an increased number of people diagnosed with silicosis and silico tuberculosis in developing countries as well as some parts of the developed countries. Kunda-Nqob'TB pioneered a silicosis screening project in partnership with Baines Occupational Clinic and Ministry of Health and Child Care in Zimbabwe. The project was implemented in eight districts that have high artisanal mining activities and a disproportionate burden of TB disease. Unpublished statistics from 2019 to the second quarter of 2024, 12037 artisanal small-scale miners were screened for tuberculosis, 11479 were screened for silicosis, 921 were diagnosed with tuberculosis, 2146 were diagnosed with silicosis while 555 were diagnosed with silico tuberculosis among the screened 3067 (The Union Zimbabwe Trust, 2024).

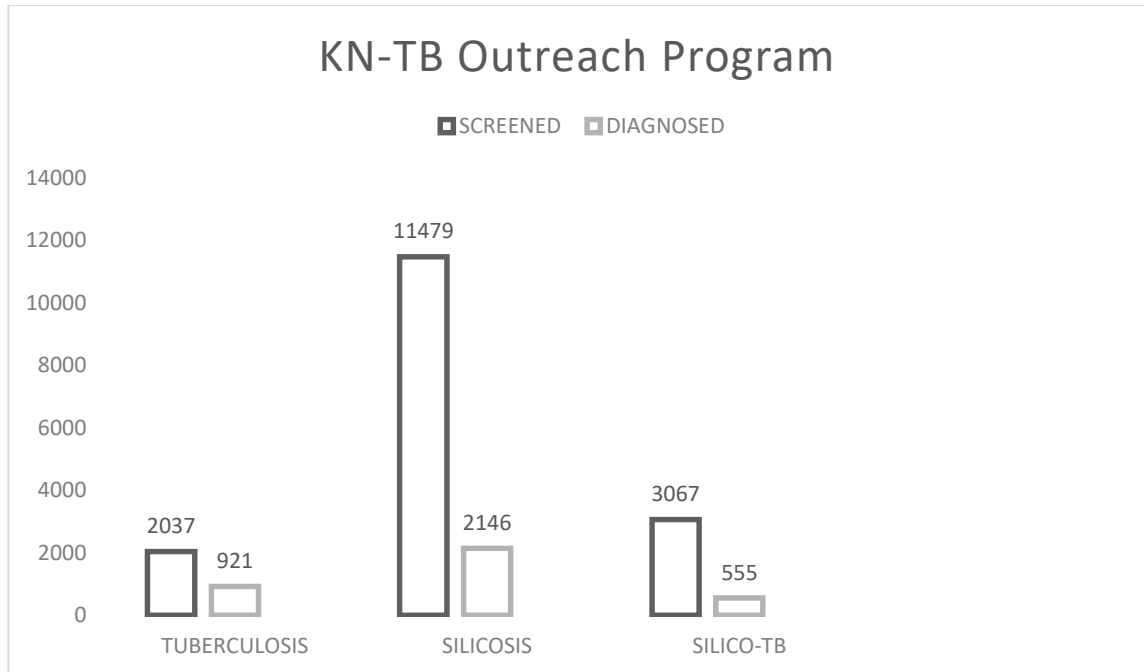


Figure 1: KN-TB Artisanal Miners Outreach Screening Program 2022-2024

(The Union Zimbabwe Trust, 2024).

The researcher investigated the impact of silicosis on TB treatment outcomes in the context of Kwekwe City.

1.3 Research Objectives

- i. To assess the death rate of silicosis, tuberculosis and silico tuberculosis patients in Kwekwe City from 2022 to 2024.
- ii. To assess the success rate of tuberculosis treatment among both tuberculosis and silico tuberculosis patients in Kwekwe City from 2022 to 2024.

- iii. To determine the rate of lost to follow up of tuberculosis, silicosis and silico tuberculosis patients in Kwekwe City from 2022 to 2024.
- iv. To determine the rate of tuberculosis treatment, fail among tuberculosis and silico tuberculosis patients in Kwekwe city from 2022 to 2024

1.4 Research Questions

- i. What is the death rate of silicosis, tuberculosis and silico tuberculosis patients in Kwekwe City from 2022 to 2024?
- ii. What is the success rate of tuberculosis treatment among both tuberculosis and silico tuberculosis patients in Kwekwe City from 2022 to 2024?
- iii. What is the rate of lost to follow up of tuberculosis, silicosis and silico tuberculosis patients in Kwekwe City from 2022 to 2024?
- iv. What is the rate of tuberculosis treatment fail, among tuberculosis and silico tuberculosis patients in Kwekwe city from 2022 to 2024

1.5 Assumptions/Hypotheses

Silicosis has a bearing on unfavorable Tuberculosis treatment outcomes

1.6 Significance of the Study

The study sought to explore and understand the contribution of silicosis to tuberculosis treatment outcomes and offered recommendations that can guide healthcare workers and patients from diagnosis to treatment and care of tuberculosis and silicosis patients in the Zimbabwe Midlands Kwekwe Context.

1.7 Delimitation of the Study

The study was conducted in Midlands Province, Kwekwe District, focusing on Tuberculosis, Silicosis and Silico Tuberculosis patients with evaluated treatment outcomes at the five Kwekwe City Council Clinics namely Al Davies Clinic, Amaveni Clinic, Mbizo 11 Clinic, Mbizo 16 Clinic and Mbizo 1 Clinic as well as Kwekwe General Hospital from 2022 to 2024.

1.8 Limitation of the Study

Some patients by nature of their work (artisanal miners) who constituted a bigger number of silicosis, tuberculosis and silico-tb patients were known for their migratory and poor health seeking behavior hence gave the researcher a challenge in evaluating their treatment outcomes. Some clinical records had missing information as reporting was paper based and staff members had rotational duties hence getting some data was be difficult.

CHAPTER 2 REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter will give a detailed review of literature relevant to the impact of silicosis on tuberculosis treatment outcomes. It will focus on occupational exposures which make people susceptible to silicosis and tuberculosis as well as the treatment outcomes from different parts of the world. Literature reviewed includes academic text books, peer reviewed journals and research papers. This chapter will show the research gaps identified through studying the literature.

According to Leung, Yu and Chen (2012), silicosis is a chronic lung disease which is caused by the inhalation of crystalline silica dust. Silicosis is rampant in a number of low- and middle-income countries. This implies that TB and silicosis are serious global health concerns in areas with significant silica dust exposure and infectious disease burdens (Hoy & Cavalin, 2022). In addition, Sharma et al. (2016) also pointed out that TB is the most prevalent clinical condition linked to silicosis, especially in countries with low or middle income. Sharma et al. (2016) went on to expound that silicosis is the second-leading risk factor for TB disease, after HIV infection. According to Hoy and Cavalin (2022) who stated that the Global Burden of Disease (GBD) study identified 23695 incident cases of silicosis in 2017.

2.2 Conceptual Framework

This study is guided by a conceptual framework that outlines exposures leading to tuberculosis and silicosis diagnosis and different treatment outcomes.

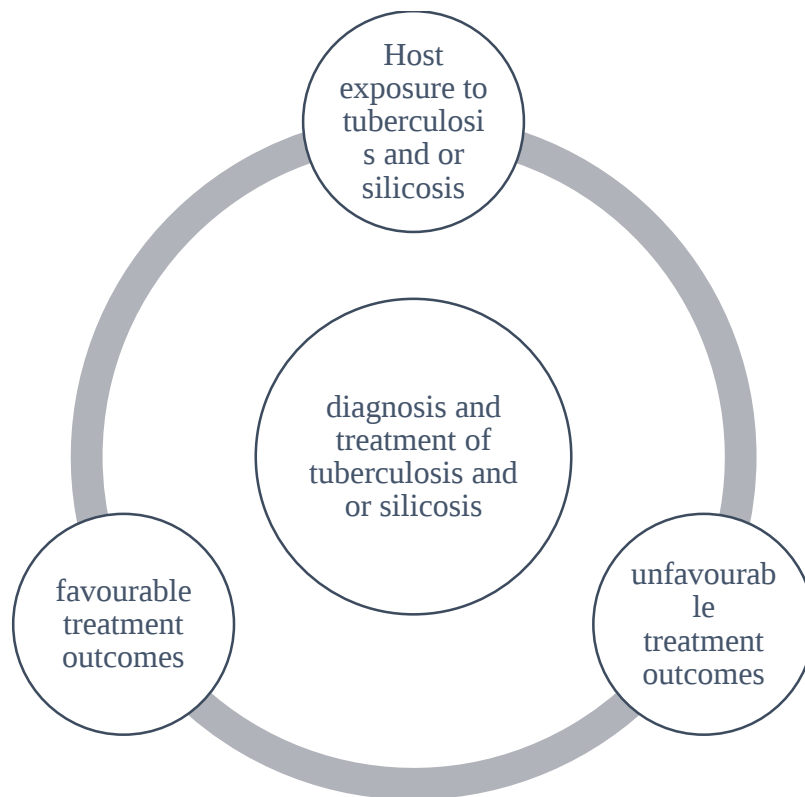


Figure 1: Conceptual Framework

A conceptual framework offers an organized methodology for comprehending how silicosis impacts the results of TB treatment by outlining the important variables and their connections within the research environment. The framework also acts as a guide for the study design, thereby assisting in the formulation of research questions, picking suitable

approaches, and determining pertinent techniques for gathering data. As a result, this framework guarantees that this research stays concentrated on the major goals and identifies the crucial elements that require measurement. Overall, this framework helps in the analysis of relationships between the TB treatment outcomes and silicosis.

2.3 Relevance of the Conceptual Framework to the study

Kwekwe is a mining town which is well known for the small scale artisanal mining activities. These activities are done in areas with poor occupational health practices hence leaving the miners exposed to both silicosis and tuberculosis. The conceptual framework emphasizes more the exposures' relationships with the treatment outcomes.

As indicated by the World Health Organization, silicosis does not only escalate the risk of respiratory morbidity but also drastically increases the risk of TB, a serious global public health concern (World Health Organization [WHO], 2021). Research has also established that silicosis can worsen the course of TB and make therapy more difficult (Knight et al., 2015). In Sub-Saharan Africa, especially Zimbabwe, silicosis and TB are particularly prevalent due to widespread mining and inadequate worker protection (Knight et al., 2015). A sizable section of Zimbabwe's workforce is employed in the gold, chrome, and asbestos mining industries, making the nation largely dependent on mining.

According to a study by Moyo et al. (2023), miners in areas like Midlands in Zimbabwe are particularly affected by the high prevalence of silicosis and TB. This means that silicosis and TB pose a serious threat to public health especially in areas with a notable

history of heavy mining activities, like Kwekwe City which is located in Zimbabwe's Midlands Province. This due to the frequency in which miners are exposed to silica dust. As a result, the nation is dealing with a simultaneous plague of silicosis and TB which requires efficient measures to be implemented so as to eradicate or mitigate this plague. Failure to implement quality measures will result in significant public health ramifications due to this dual burden.

Subsequently, significant public health difficulties arise due to this overlap of silicosis and TB, which jointly contribute to the newly emerging health issue of silico-tuberculosis. Research has found that symptoms of silicosis include chest tightness, shortness of breath, chest pain, cough, hemoptysis, sputum expectoration and subsequent complications such as respiratory tract infection may be experienced (Yao et al., (2022).

This implies that in mining towns like Kwekwe city, the burden of silico-TB cannot be overlooked. Existing research on silicosis, tuberculosis, and their combined effects on treatment outcomes is reviewed in this literature review, with particular attention to death rates, treatment failure rates, treatment success rates, and lost follow-up rates. Comprehending these patterns is essential for creating focused therapies and enhancing the health of this susceptible group by implementing effective interventions to improve TB, Silicosis and Silico-TB prevention and treatment in Zimbabwe.

2.4 Epidemiology of Tuberculosis and silicosis

In 2017, silicosis accounted for 39% of all pneumoconiosis cases worldwide, making it one of the most prevalent occupational diseases in the world (Rupani, 2023). According to Leung et al. (2012), silicosis is a chronic lung disease caused by the inhalation of crystalline silica dust during long-term occupational activities. Silicosis is characterized by the development of irreversible and progressive pulmonary fibrosis (Liu et al., 2023).

WHO (2021) estimated that 1.5 million people died from TB out of the 10 million people who were infected with TB in 2020, globally and an estimated 29,945 individuals in Zimbabwe were reported to have contracted active tuberculosis in 2021. According to reports from WHO, the global incidence of TB has been gradually decreasing since 2002. However, the rate of progress has been uneven as evidenced by the fact that the average annual incidence has decreased by roughly 1.5%, which is not enough to reach the WHO's aggressive TB elimination goals. These goals entail a 90% reduction in TB deaths and 80% reduction in TB incidence by 2030 compared with 2015 levels (WHO, 2015).

On the other hand, Zimbabwe has made significant progress in lowering its TB burden as it is no longer among the 30 nations with the highest TB burden in the world. However, WHO indicated that despite the advancements made, the rate of TB incidence reduction in Zimbabwe is not rapid enough to eradicate the illness. WHO went on to accentuate that there are still a lot of individuals who are being overlooked and are failing to receive the necessary care (WHO, 2023). Subsequently, this shows that more effort is needed in implementing the measures that can swiftly help in the eradication of TB. The risk factors for TB in Zimbabwe includes high rates of HIV co-infection, socioeconomic challenges, and occupational exposures, especially in mining communities.

Research highlighted that the relationship between silicosis and TB prevalence rates in artisanal and small-scale miners is a serious public health concern (Knight, Ehrlich, & Cois, 2020). This can be attributed to the manual extraction techniques which are frequently used in artisanal and small-scale mining operations thus producing a lot of silica dust. As a result, silicosis can develop due to prolonged inhalation of these silica particles. In a prevalence study of 624 former Lesotho gold miners, 18 months after their employment at a South African mine had ended, nearly 25% had silicosis; 26% of those for whom data was available had a history of tuberculosis; 1.3% were already taking anti-TB medications; 2.9% had active, undiagnosed tuberculosis; and 2.1% were prescribed anti-TB medication for clinical reasons, (Girdler-Brown, White, Ehrlich, & Churchyard).

2.5 Human Exposure to Silica Dust

Although sectors associated with the crystalline silica are closely monitored and managed, a significant number of people around the world are believed to be impacted by occupational exposure to crystalline silica each year. This can be attributed to the naturally occurrence of crystalline silica in soil, sand, and rock (Wardyn et al., 2024). Therefore, since the main cause of silicosis is exposure to silica dust, the disease is concentrated in areas where silica dust-producing industries are situated. Subsequently, professions such as mining, construction, quarries, foundries, cement, and stone cutting are primarily linked to silicosis. The World Health Organization also stated that silicosis is a significant occupational illness in low- and middle-income nations including Zimbabwe (WHO, 2020). Moreso, in Zimbabwe, silicosis has been particularly common in mining

communities like Kwekwe, where the extraction of gold and other minerals is a significant industry.

Despite the efforts by various organizations to eradicate silicosis by 2030, the disease remains a major public health concern in several countries. Global research conducted by Liu et al. (2023) established that number of silicosis cases rose by 64.6% on a global scale from 1990 to 2019. Another research highlighted that 2.65 million cases of silicosis with an incidence rate and death rate of 1.7 and 0.2 per 100,000 populations respectively were reported globally in 2019 (Rupani, 2023). According to the Intergovernmental Forum on Mining an estimated 227 million workers, most of whom are informal and often migrants, are at the highest risk of contracting silicosis (Intergovernmental Forum on Mining [IFM], 2018). The Intergovernmental Forum on Mining went on to highlight that up to 1.7 million workers are reported to have been exposed to silica at work each year in the United States of America.

2.6 Human Exposure to Mycobacterium Tuberculosis

On the other hand, TB is a communicable disease that is considered to be one of the leading causes of death worldwide. Research has established that TB is caused by the bacillus *Mycobacterium tuberculosis* which is spread when people who are infected with TB expel bacteria into the air, for instance through coughing. The typical symptoms of pulmonary tuberculosis include a cough lasting more than two weeks, chest pain, coughing up blood or sputum, weakness, weight loss, poor appetite, fever, and night sweats (Chadambuka et al. 2011).

According to WHO (2016), TB continues to be an important and major public health concern especially in low- and middle-income countries like Zimbabwe. This is in sync with the research conducted by Matteelli and Raviglione (2014) in which they opined that TB is definitely a disease associated with poverty, mostly impacting the most vulnerable groups in the world's low- and middle-income nations. Sulis et al. (2014) went to indicate that early TB case detection is still difficult, particularly in settings with limited resources and among marginalized groups leading to an estimated population of 3 million people being left out misdiagnosed, uninformed, and untreated.

Another study involving 2255 South African gold miners who were monitored for 24 years to 27 years revealed a mean of 7.6 years between the end of silica dust exposure and the diagnosis of pulmonary tuberculosis. The study also found that the severity of silicosis, if present, and the intensity of exposure are related to the risk of developing pulmonary tuberculosis (Knight, 2020). This observation was similar to that of Cowie (1994) in which patients with silicosis were found to have an estimated 2.8 times the relative chance of developing pulmonary tuberculosis. More so, Cowie (1994) also highlighted that the risk of developing extra-pulmonary tuberculosis by silicosis patients can be as high as 3.7 times that of those without silicosis. These results indicate that there is a significant relationship between exposure to silica dust, which in turn cause silicosis, and development of TB.

The adverse effect that silica exposure causes to the lungs is determined to be the main pathophysiological link between silicosis and tuberculosis (Knight, 2020). Silicosis causes fibrotic lesions and nodules to grow in the lungs, which can impair the lung's capacity to fight off infections. Since silica particles cause inflammation and fibrosis, they

can disrupt the lungs' natural immunological response. This suggests that persistent inflammation and the development of scar tissue may foster an environment that allows the TB germs to persist. Even in the face of immunological responses, TB bacilli can proliferate in fibrotic lung tissue (Ehrlich, Akugizibwe, Siegfried & Rees, 2021). This means that when TB bacteria enter the lungs, they have an opportunity to grow and spread infection because of the previously damaged tissue.

2.7 Association between Silicosis and Pulmonary Tuberculosis

Several studies have also highlighted that there is an association between crystalline silica exposure and silicosis and pulmonary tuberculosis especially in mining environments (Naude et al., 2006; Hnizdo & Murray, 1998). Zimbabwe is one of the countries in Africa where mining activities are rampant and it has an estimated population of over 500,000 artisanal and small-scale miners (Moyo et al., 2022). According to the Zimbabwe National statistics agency (2012), the majority of artisanal and small-scale miners are found in the Midlands province, which has 19457 artisanal and small-scale miners, followed by Mashonaland west, and Matabeleland south, which have 13267 and 12153 artisanal and small-scale miners respectively. It is estimated that there are between 3000 to 7000 cases of tuberculosis per 100,000 miners in Southern Africa. According to reports, this rate was found to be three to ten times more than that of the general population (Mbuya et al., 2023).

Furthermore, according to studies silicosis is quite prevalent in Zimbabwe, affecting an estimated population of 18 to 21% of ASMs (Moyo et al., 2022). Studies have also indicated that individuals with silicosis are more likely to die from tuberculosis than those

without the disease, highlighting the necessity of focused interventions in high-risk groups. Therefore, since Kwekwe is one of the places in the Midlands with the highest number of artisanal and small-scale miners (ASMs) specific health interventions are desperately needed to alleviate the dual burden of TB and silicosis.

There is a strong interaction between tuberculosis and silicosis which considerably impedes clinical outcomes, especially in high-risk settings like mining environments. Therefore, developing successful preventive and control strategies requires an understanding of this interplay, especially in areas with a high concentration of mining activities like Kwekwe City.

Silicosis leads to an impaired immune response in the lungs. The lungs are the most affected by tuberculosis hence susceptibility of the patient is increased greatly by silicosis. The inhalation of silica dust leads to macrophage dysfunction. Silica dust particles have a tendency of disrupting the normal functioning of the macrophages. This then reduces their ability to kill the bacterium that causes tuberculosis which is known as mycobacterium tuberculosis. Silicosis also disrupts the ability of immune response of the body through altered cytokine production. Cytokines which are disrupted by silicosis are essential for immune response. They help the body fight TB infection.

2.8 Tuberculosis and Silicosis Interaction

Silicosis is a fibrotic disease which causes lung fibrosis. An environment conducive for TB proliferation is created because of the fibrosis. Survival and replication of TB bacteria is made possible by the fibrotic nodules which are formed in the lungs by silicosis. These are the sites where entrapment of TB bacteria hence facilitating their survival and growth. Fibrotic changes in the lungs also impair gas exchange due to reduced lung function. This leads to respiratory problems among patients. The fact that a patient reports respiratory problems points also to the risk of TB infection sometimes due to the fact that the lung is already damaged.

Occupational diseases common among miners include TB and silicosis. The occupational environment plays an important role in increase the risk of TB and silicosis among workers. Most silicosis patients have worked or are working in the mining industry where exposure to silica dust is high. Sometimes due to socio-economic challenges, problems of silicosis and TB are on the increase due to over-population, poor living and working conditions. As a result, these conditions facilitate the spread of TB, according to (WHO, 2023).

It is essential to understand the interaction between TB and silicosis. These include immunological, environmental and pathological factors. These help in developing targeted intervention for the prevention and control of TB and silicosis among the most basic ones. The most basic interventions being used at the moment are enhanced screening, early diagnosis and effective management of patients with silicosis and TB. These interventions help reduce morbidity and mortality associated with TB and silicosis.

2.9 Treatment Success rates

2.9.1 Tuberculosis Treatment success rates

Globally, the treatment success rate for TB was reported by WHO to be 88% which is also similar to the success rate of TB on the African continent (WHO, 2015). At national level, the TB treatment results in Zimbabwe have steadily improved, reaching an 84.0% success rate by 2018, however they still don't meet the country's 90.0% goal (MoHCC. 2020). The Global TB Report 2023 estimates that 33,000 people in Zimbabwe have TB, with a 90% success rate for drug-sensitive TB and a 42% success rate for multi-drug-resistant TB (MDR-TB) (WHO, 2023). This is comparable to the findings of Moyo et al. (2024) in which they observed a high treatment success rate of around 87% for drug sensitive TB. Research conducted by Gabida et al. (2015), revealed that between 2007 and 2011, the TB success rate in Kwekwe was determined to be lower than WHO's targets, ranging from 40.8% to 64.3%.

Gabida et al. (2015) observed that the low success rate obtained can be ascribed to the high defaulter rate which ranged from 4.0% to 12.0%. furthermore, Gabida et al. also pointed out that treatment completion rate, which ranged from 15.5% to 30.4%, as well as the death rate, which ranged from 5.3% to 13.7%, could also be other factors affecting the success rate of TB treatment. In addition, another reason suggested for poor treatment success rate in the study by Gibida et al. (2015) was due to the fact that a facility-based Directly Observed Therapy (DOT) Clinic was used in the research. This factor was determined to have an impact on treatment outcomes by a study conducted in Tanzania in

which 81% of patients receiving community-based (DOT) whilst 70% of patients receiving facility-based DOT experienced successful treatment (Boogaard, 2009).

This suggested that in order to enhance treatment outcomes, facility-based DOTs should have a significant community component, particularly when it comes to defaulter tracing and counseling. A facility-based DOT clinic is a medical facility where patients receive their TB drugs under the supervision of medical staff, usually within the clinic. This method differs from community-based treatment, which may provide care in more decentralized settings, such as patients' homes (Boogaard, 2009).

2.9.2 Treatment Success Rates for Silico-TB

Research by WHO (2023) also shows that treatment success rates for silico-TB patients worldwide are much lower, frequently between 50% and 70%. It has been observed that patients with silicosis have a poorer treatment success rate than those with TB alone because silicosis deteriorates the clinical results of TB treatment. Furthermore, those patients with significant silicosis or extensive pulmonary impairment may have a lower success rate than the typical TB-only rate. This is in sync with research by Albadrani (2023) in which he indicated that silicosis patients frequently have greater risks of TB treatment failure. In addition, Albadrani (2023) went on to accentuate that treatment failure can be ascribed to the impairment brought on by silicosis which negatively impacts lung function thus complicating the effectiveness of TB treatment. As a result, anti-TB

drug absorption may be hampered by this damage, resulting in decreased plasma concentrations and less than ideal therapy results.

2.10 Death rates

2.10.1 Silico-TB Death Rates

Globally, mining locations with high levels of silica dust exposure, such as South Africa, Brazil, India, and Zimbabwe, have documented disproportionately high mortality rates among those who co-infect with silicosis and tuberculosis. Between 2019 and 2021, the estimated total number of TB-related deaths worldwide rose from 1.4 million to 1.6 million, according to Chakaya et al. (2021). Patients with tuberculosis (TB), especially those with silicosis, have a very high mortality rate. According to research by WHO, individuals infected with both silicosis and TB have a far higher chance of dying compared to those with TB only.

A study by Rupani et al. (2023) also highlighted that silicosis patients are four to six times more likely to die from TB-related complications compared to those without silicosis. This is similar to a study conducted in South Africa by Knight (2015), in which individuals with silicosis who also had TB had a mortality rate that was up to four times greater than that of patients with TB alone. Furthermore, the chronic nature of silicosis, according to this study, exacerbated the advancement of tuberculosis and increased mortality rates, especially among miners. This increased mortality is attributed to the compromised lung function and immune response characteristic of silicosis, which exacerbates the severity of TB infections.

According to the Ministry of Health and Child Care, one of the major public health concerns in Zimbabwe is the death rate of silico-tuberculosis patients (Ministry of Health and Child Care [MoHCC], 2021). The Ministry of Health and Child Care went on to elaborate that the mortality rate for silico-tuberculosis patients in Zimbabwe is much higher than the rate for the general TB population. This is consistent with the study conducted in India by Rupani et al. (2023) in which they highlighted that the individuals with silico-tb had three times the chance of dying from TB as opposed to those with a TB diagnosis alone (Rupani, 2023). In addition, this study also revealed that 11% of the 137 people who had developed silicosis succumbed to the disease (Rupani, 2023). In Kwekwe city, 39 people were reported to have succumbed to silicosis between 2023 and July 2024. In conclusion, the co-existence of silicosis and TB significantly exacerbates disease severity and mortality rates. Worldwide, silicosis and tuberculosis co-infection mortality rates are disproportionately high in mining regions with high silica dust exposure, such as South Africa, Brazil, India, and Zimbabwe. Research shows that compared to TB patients without silicosis, those with silicosis have a four to six times higher risk of dying from TB-related sequelae. For instance, silicosis quadruples the risk of mortality and worsens the course of tuberculosis, according to data from South Africa. One of the biggest causes of death in Zimbabwe is still TB, especially for miners who are exposed to silica dust.

2.10.2 Tuberculosis Death Rates

In Zimbabwe, tuberculosis continues to be one of the leading causes of death. Research indicated that the major contributing reason to the high death rate of tuberculosis patients

in Zimbabwe is silicosis. According to the National Tuberculosis Programme, TB is still one of the top causes of death in Zimbabwe, particularly for people who work in high-risk jobs like miners and industrial workers who are exposed to silica dust.

In 2019, an estimated number of 29,000 people were reported to have been infected with tuberculosis, and it has been also reported that about 6,300 of them passed away (WHO, 2021). In the last quarter of 2020, a death rate of 14% for TB patients was recorded in Gweru District (Mando et al., 2023). Moreover, Mando et al. (2023) observed a high TB death rate in areas where ASM activities are common such as Mutare and Bulawayo.

A cohort analysis conducted in Kwekwe by Gabida et al. (2012) indicates that the death rate for TB patients was around 12%. This is an indication of the impact of ASM mining activities on TB.

According to the National Tuberculosis Programme, 6,300 people died from TB in 2019, out of 29,000 TB cases.

According to research from Zimbabwe's Ministry of Health and Child Care, the death rate among silico-TB patients is higher than that of the general TB population (MoHCC, 2018). This finding is consistent with international research showing that silico-TB patients had a threefold increased risk of dying from TB sequelae, including research done in India. All things considered, the data emphasizes how urgently focused public health initiatives are needed to address the increased risks of silicosis and silico-TB, especially in mining villages like Kwekwe. Reducing silica dust exposure, improving TB treatment results, and addressing systemic health disparities in high-risk groups should be the main objectives of effective solutions.

2.11 Rate of loss to follow of tuberculosis and silico-tuberculosis patients

A major worldwide health concern is loss to follow-up (LTFU) among patients with TB and silico-TB. This implies that LTFU among TB and silicosis patients is a serious problem which needs proper prevention and management so as to reduce mortality and prevent further spread of the disease. The term "loss to follow-up" describes patients who, after receiving a diagnosis of tuberculosis (TB) or silico-tuberculosis (silico-TB), discontinue their treatment or neglect to show up for their planned follow-up sessions. This may happen during the initial diagnosis, throughout the course of treatment, or during routine evaluations, among other points in time (Soedarsono et al., 2021).

Research established that patient compliance with recommended treatment plans, prompt follow-ups, and regular monitoring are critical to the effective treatment and management of these conditions (Soedarsono et al., 2021). Significant public health hazards arise from patients who are lost to follow-up because they may have protracted illness, treatment failure, or possibly acquire drug-resistant TB. Therefore, in order to improve patient outcomes, stop additional transmission, and save healthcare expenses related to these diseases, it is important to recognize and manage the factors that contribute to LTFU. In other terms, it is essential to track the rate of loss to follow-up among patients with TB, silicosis, and silico-tuberculosis in order to comprehend treatment compliance and general health outcomes.

Moreover, it is of paramount importance to monitor rate of LTFU since high follow-up loss rates can worsen public health issues and compromise the effectiveness of treatment (Soedarsono et al., 2021). According to the 2021 World Health Organization (WHO)

annual TB report, the percentage of LTFU remained at 6% worldwide between 2012 and 2019, with a significant number of LTFU cases in recent years. Nonetheless, there are geographical differences in these rates, with several nations reporting significantly greater rates. For instance, in high-burden TB settings, LTFU rates may vary based on patient demographics, socioeconomic circumstances, and the local healthcare infrastructure. A study conducted by Rupani (2023) indicated that 5% of people infected with TB were lost to follow up, whilst 12% of patients with silico-tuberculosis in a clinical trial in Hong Kong were also lost to follow up. Subsequently, this has resulted in treatment failure or death, illness transmission in households and communities, and drug resistance.

2.11.1 Silico-TB and TB Patients loss to follow up

People who have silico-TB have an even harder time finishing their treatment plans and going to follow-up appointments. In addition, these statistics highlight the severe effects of LTFU, including as treatment failure, elevated mortality, community-wide disease transmission, and drug resistance. A study conducted in China indicated a 12.55% rate of LTFU for TB patients (Jiang et al., 2023). Jiang et al. went to indicate that the majority of patients who were LTFU were lost during the initial phase of treatment, that is the first 3 months. The study highlighted that the incidence of LTFU was greater before regimen commencement than after among individuals with a prior TB history who were seen in outpatient clinics (Jiang et al., 2023). This suggests that when re-treated TB patients are seen in an outpatient clinic, particularly prior to the initiation of therapy, they should get additional health education and follow-up reminders.

In addition, research in India established that psychological distress, a lack of social support, stigma, and unfavorable treatment attitudes are linked to the greater incidence of LTFU in re-treated patients (Zhou et al. 2020). In Zimbabwe, another major public health concern is the prevalence of loss to follow-up among TB patients, especially those with silico-tuberculosis. This phenomenon refers to those patients who start treatment but stop taking it as prescribed or fail to show up for follow-up appointments. According to Mando et al., 2023, Zimbabwe has a high percentage of unreported TB treatment outcomes and losses to follow-up along the cascade. A study conducted by Murongazvombo et al. (2019) in Guruve indicated that the rate of pre-diagnosis LTFU cases for TB was 19%. This indicates that a sizable fraction of TB patients never ever begins their treatment.

Another study by Moyo et al. (2024) highlighted that the LTFU cases was 7% among ASMs in Zimbabwe. This implies that the proportion of TB and silico-tuberculosis patients in Zimbabwe losing their follow-up is a serious problem that needs to be addressed. Due of the complexity of controlling both silicosis and TB, patients in Zimbabwe who have silico-TB are especially vulnerable to treatment disruptions. According to studies, people with silico-tb are more likely to experience treatment interruptions or discontinuations due to the compounding effects of their condition (Rupani et al., 2023). This is in sync with the results from a clinical trial in Hong Kong that indicated that 12% of patients with silico-tb were lost to follow-up compared to the 5% with TB only.

2.11.2 Factors Contributing to Loss to Follow Up

Research indicates that there is a co-relationship between socio-economic factors and the rate of LTFU. Mando et al. (2023) opined that since many patients are from low-income families, it might be challenging to afford transport cost to medical facilities thereby failing to have follow up visits done. In addition, economic difficulties and high unemployment rates associated with Zimbabwe may also make it difficult for patients to access dosages and follow-up visits as a result of prioritizing employment over medical appointments due to economic difficulties (Mando et al., 2023). Rupani et al. (2023) also indicated in his study that regular medical attendance by patients was hampered by long commutes to clinics, lack of transportation, and poor healthcare facilities, especially for silicosis patients who had been already be dealing with health issues.

Jiang et al. (2023) also noted in his study that patients may be deterred from seeking treatment or coming back for follow-up due to the stigma attached to silicosis and tuberculosis. This implies that patients may completely shun hospital settings out of fear of social isolation or discrimination. All in all, one major issue that jeopardizes the effectiveness of treatment programs and attempts to stop the spread of TB and silico-TB is the rate of loss to follow-up (LTFU) among patients with these diseases. LTFU is still high in both local and global contexts, especially in Zimbabwe, where socioeconomic constraints, problems with the healthcare system, stigma, and psychological reasons all play a part.

As a result of the complicated nature of their therapy and the compounding consequences of silicosis, the situation is considerably worse for individuals with silico-TB. Improving

patient education, tackling socioeconomic issues, fortifying healthcare systems, and offering all-encompassing assistance to individuals with co-morbid disorders like silicosis must be the main priorities of efforts to lower LTFU. We can only expect to increase treatment adherence, lower transmission, and improve public health outcomes by using these integrated approaches.

A comprehensive strategy that takes into account the social, psychological, economical, and logistical aspects that affect treatment compliance is needed to address this problem. According to (Rupani et al., 2023), the incidence of LTFU among TB and silico-TB patients can be decreased by healthcare providers through the use of focused therapies, improved patient education, and community engagement. Better health outcomes, lower rates of transmission, and a more successful public health response to these interrelated diseases will result from this. This means that the path to an improved TB and silico-TB management in Kwekwe City and the world at large depends on the capacity of health professionals to comprehend and manage the difficulties associated with LTFU. As a result, this will ultimately lead to healthier communities and a more robust healthcare system.

2.12 Impact of Silicosis on TB Treatment Outcomes

Globally, silicosis is an issue, especially in nations where occupational exposure to silica dust is common. According to WHO (2019), both TB and silicosis pose serious health risks in many parts of the world, especially in areas with heavy industrial activity and

occupational silica dust exposure. Several research has established that silicosis and TB are more common in regions like Southern Africa, Asia, and Latin America as a result of rife mining and industrial activities taking place in these regions (Murray, Davies & Rees, 2011; Rupani, 2023; Yarahmadi et al., 2013). One of the main causes of the combined burden of silicosis and tuberculosis in Southern Africa is the mining sector (Hnizdo, & Murray, 1998). WHO (2018) indicated that South Africa, Namibia, and Zimbabwe have some of the highest rates of TB in the world, which is made worse by silicosis.

There is a strong link between silicosis and a higher risk of tuberculosis, according to research done in Southern Africa by Hnizdo and Murray (1998). This was also supported by research conducted by Rupani (2023) in India in which silicosis was identified as a major risk factor for TB. The study indicated that the incidence of tuberculosis was considerably greater among miners with silicosis than in the general population. The mortality rate for TB patients is found to be considerably raised when silicosis is present. This implies that silicosis patients frequently have greater risks of TB treatment failure leading to high mortality rates for silico-TB patients. According to Yarahmadi et al., (2013), individuals who have both silicosis and TB have higher mortality rates than those who only have TB. This was found to be especially true in areas where mining activities and other industrial activities are rampant.

2.12.1 Health Complications of Silicosis

Silicosis causes TB to proceed more quickly, resulting in more severe forms of the illness and a higher chance of mortality (Moyo et al., 2024). Moreso, silicosis weakens the immune system since exposure to silica damages the lung tissues. This in turn reduces the

lung's capacity to fight off infections. Additionally, it lowers the efficiency of macrophages, which are essential immune cells that combat TB germs. Even those who have already been exposed to *Mycobacterium tuberculosis*, the causative agent of tuberculosis, are at a higher risk of getting active tuberculosis due to this compromised immune response. Moyo et al (2023) opined that both silicosis and tuberculosis can cause symptoms which includes persistent coughing, exhaustion, and trouble breathing, which may make patients less likely to follow their treatment plans.

The results of TB therapy were also found to be negatively impacted in nations like China and India where the informal mining industry is the main cause of silicosis. Compared to those without the condition, employees with silicosis had a six-fold higher risk of developing active tuberculosis, according to an Indian study (Rupani, 2023). Patients with silicosis may not receive timely diagnosis and treatment due to this increased risk, which is exacerbated in certain areas by a lack of proper healthcare infrastructure. A study of miners in the Mexican state of Sonora revealed that silicosis and TB were highly prevalent, with silicosis considerably impairing the effectiveness of TB treatment (Sinha, Priya, & Ahmad, 2023). The study emphasized how underreporting of silicosis cases and a lack of resources make it difficult to provide prompt and efficient treatment.

In another research by Albadrani (2023), the treatment plans for tuberculosis may need to be modified in the presence of silicosis. This implies that patients with silicosis, for instance, could need longer treatment regimens and more frequent monitoring because of the intricacy of their condition. Treatment regimens may become even more complex if there are negative interactions between TB drugs and the respiratory issues brought on by silicosis. Subsequently, patients with silicosis may require longer TB treatment regimens because of consequences from the co-morbid illness. Thus, management of both silicosis

and TB may also require more regular monitoring and follow-up visits, which would put a burden on medical resources.

2.12.2 The negative impact of silicosis on TB treatment outcome

According to Rupani et al., individuals who have silico-tuberculosis are 2.3 times more likely to experience poor TB treatment results such as stopping treatment, having a positive sputum smear at the end of treatment, or passing away while receiving treatment. A multi-study conducted by Albadrani (2023) also revealed that it is challenging to treat TB in patients with silicosis possibly as a result of inadequate medication penetration into fibrotic nodules and/or free silica impairing macrophage activity. A number of physiological alterations brought on by silicosis can make treating tuberculosis more difficult. Silicosis damages the lungs and weakens the immune system, which makes it harder for the body to fight against TB infections. Patients with silico-tuberculosis may experience more treatment failures and relapses as a result of this impairment (Rupani, 2023).

Furthermore, according to a Hong Kong clinical trial, individuals with silico-tuberculosis need to take a four-drug first-line regimen for at least eight months in order to experience positive treatment results (Tuberculosis Research Centre, 1991). Moreover, 22% of silico-tuberculosis patients were found to experience adverse medication reactions in the Hong Kong clinical study. Research also indicates that it takes less time for TB patients to experience positive treatment outcomes as compared to silico-tuberculosis patients. This is an indication that silicosis has a major impact on the treatment outcomes for TB patients.

Rupani (2023) also highlighted that the possibility of getting poor treatment outcomes increase with an increase in age. This is line with the observations made from a study conducted by Gibida et al. (2015) in Kwekwe city where the frequency on poor treatment outcomes was significantly higher among patients above 65 years of age.

Another research by Chaudhury, Phatak, Paliwal and Raichaudhari (2010) indicated that silicosis is linked to increased rates of drug-resistant TB as well as poor treatment adherence, both of which raise the chance of treatment failure. This means longer treatment plans, more stringent monitoring, and the use of second-line anti-TB medication, which are less effective and more toxic, are frequently required when silicosis and TB co-occur. Furthermore, the intensity of TB symptoms may worsen due to silicosis, which could delay sputum conversion and lower treatment success rates overall. On the other hand, people who have silicosis frequently exhibit unusual TB symptoms, which delays diagnosis and treatment. Furthermore, because the clinical presentation of silicosis may resemble that of other respiratory conditions, it might be difficult to diagnose (Farazi, & Jabbariasl, 2015).

2.12.3 Impact of late TB Diagnosis in Silicosis Patients

Subsequently, the delayed identification of TB leads to poorer treatment outcomes in patients with silicosis. Moreso, this delay is also characterized by a higher chance of complications such as multidrug-resistant (MDR) TB. As a result, silicosis increases the possibility of medication resistance which makes managing of tuberculosis more difficult. This was also highlighted in a study conducted by Chaudhury et al. (2010) in which TB

treatment outcomes were found to be worse in people with silicosis due to comorbidities linked to silicosis, delayed diagnosis, and limited access to healthcare.

Conclusively, the incidence of tuberculosis among patients with silicosis is significantly greater than in the general population, and the co-occurrence of these illnesses has a detrimental effect on the effectiveness of TB treatment. In contrast to the approximately 88% success rate for TB therapy worldwide, silico-TB patients frequently have lower success rates, usually between 50% and 70%. Lung damage from silicosis raises death rates, complicates treatment plans, and decreases the effectiveness of medications. For example, silico-TB patients are more likely to experience multidrug-resistant TB (MDR-TB), extended hospital stays, and treatment failure. National TB treatment success rates in Zimbabwe have increased over time, rising to 90% for drug-sensitive TB in 2023 and 84% by 2018. Nevertheless, the success rate for MDR-TB treatment is still low at 42%.

Effective therapy is further hampered by delayed diagnosis brought on by overlapping silicosis and tuberculosis symptoms. Atypical TB symptoms are frequently seen in silicosis patients, which can cause delays in diagnosis and higher fatality rates. According to research from Ethiopia, Mexico, and India, silicosis makes tuberculosis worse by impairing the immune system and hastening the course of the illness. Additionally, issues including poverty, lack of access to healthcare, and stigma all affect treatment adherence.

2.12.4 Approaches to address the burden of TB and Silicosis

In order to address the twin burden of silicosis and tuberculosis, especially in high-risk work contexts, studies highlight the necessity of integrated public health measures. To

improve outcomes for silico-TB patients around the world, more occupational safety protocols, better diagnostic instruments, and easier access to healthcare are crucial.

With an estimated 2.65 million cases and a death rate of 0.2 per 100,000 worldwide in 2019, the number of silicosis cases increased by 64.6% between 1990 and 2019. The high frequency is caused by a number of factors, such as inadequate safety laws, a lack of protective gear, and a lack of awareness about occupational dangers. Given that silicosis affects 18 to 21% of artisanal and small-scale miners (ASMs) in Zimbabwe, focused health interventions are desperately needed. Furthermore, the risk of TB is greatly increased by silicosis, especially in mining settings. According to studies, persons with silicosis had a 2.8 to 3.7 times higher risk of developing extra-pulmonary or pulmonary tuberculosis than patients without the disease. Exposure to silica causes fibrosis, lung damage, and weakened immune systems, all of which foster an environment that is favorable for tuberculosis infection. High rates of silicosis and TB co-infection are caused by silica exposure from mining activities, particularly artisanal and small-scale enterprises.

The co-occurrence of silicosis and TB negatively impacts the efficacy of TB treatment, and the incidence of TB in patients with silicosis is much higher than in the general population. This indicates that the difficulties in treating both silicosis and tuberculosis are made worse by their interaction. In addition, the success rate for silico-TB patients in Zimbabwe is was found to be low, often between 50% and 70%, compared to the global TB therapeutic success rate of about 88%. Lung damage from silicosis is found to be associated with increased death rates. Silicosis fosters an environment that is favorable to tuberculosis infection and progression since it impairs lung function and immune system

function. Moreover, silicosis-related chronic inflammation and fibrosis may reduce the efficacy of TB treatments, increasing the likelihood of drug resistance, treatment failure, and recurrence. In addition to raising the mortality risk for those who are impacted, this dual burden significantly strains public health systems, especially in environments with limited resources.

In addition, the treatment regimens become knottier and pharmaceutical efficiency is reduced if silicosis is found to be present. The Ministry of Health and Child Care (MoHCC) in Zimbabwe has found that the mortality rate among silico-TB patients is more than that of the overall TB population. This result is in line with global studies that found silico-TB patients had a threefold higher chance of dying from TB-related complications.

Because silicosis impairs lung function and immune system function, it fosters an environment that is favorable to tuberculosis infection and progression. Moreover, silicosis-related chronic inflammation and fibrosis may reduce the efficacy of TB treatments, increasing the likelihood of drug resistance, treatment failure, and recurrence. In addition to raising the mortality risk for those who are impacted, this dual burden significantly strains public health systems, especially in environments with limited resources.

Moreover, socioeconomic challenges, problems with the healthcare system, and impaired lung function are some of the factors causing negative treatment results leading to high mortality rates. Additionally, because treatment adherence is frequently lower, the presence of silicosis has a negative impact on TB treatment success rates. This review also explores the problem of TB patients' loss to follow-up, highlighting the various ways in which stigma and socioeconomic obstacles prevent regular care. Literature gaps were also

noted, especially the requirement for Kwekwe City-specific localized studies to have a deeper understanding of the dynamics of TB and silicosis.

2.13 Gaps in literature

A major public health concern is the association of silicosis and TB, especially in mining areas such as Kwekwe City, Zimbabwe. However, even though silicosis is recognized to be linked to poor TB treatment outcomes, there is still a significant lack of literature that particularly addresses this problem in the context of Kwekwe City and Zimbabwe as a whole. The lack of localized research that explicitly look at how silicosis affects TB treatment results in Kwekwe City is one of the key gaps in the literature. Although there are more general studies on silicosis and tuberculosis in Zimbabwe and other nations, Kwekwe, a city well-known for its mining operations, has particular socioeconomic and environmental characteristics that call for targeted research.

Workers in Kwekwe's mining industry are exposed to silica dust, which raises their risk of silicosis and, in turn, makes TB treatment outcomes more difficult (Knight et al., 2020). However, there is a lack of precise data on the mortality rates of TB and silico-tuberculosis patients in this area, which makes it challenging to develop efficient public health initiatives.

The lack of knowledge regarding the treatment failure rate among TB and silico-tuberculosis patients in Kwekwe City represents another important knowledge gap. The material that is now available frequently compiles information from multiple locations

without focusing on the particular difficulties that patients in Kwekwe experience. This implies that treatment results can be greatly impacted by variables like the degree of silicosis, socioeconomic position, and availability to medical care. Subsequently, as highlighted by Lumpkin et al., (2006) health authorities may find it difficult to put tailored initiatives to lower treatment failures, which are essential for improving health outcomes, into practice without localized data.

In a nutshell, the necessity for targeted research in this field is highlighted by the gaps in the literature about the effect of silicosis on the results of tuberculosis treatment in Kwekwe City, Zimbabwe. In order to comprehend the particular difficulties faced by TB and silico-tuberculosis patients and to create successful public health initiatives, these gaps must be filled. In order to guide evidence-based treatments that can enhance health outcomes for this susceptible group, future research should seek to gather localized data on death rates, treatment failures, success rates, and loss to follow-up.

2.14 Summery

The substantial correlation between silicosis and the results of TB treatment has been examined in this review of the literature. Understanding how silicosis impacts TB outcomes is essential for public health treatments, as the illness is highly prevalent among miners in the area. Important conclusions drawn from the literature indicates that silicosis patients had worse rates of treatment failures and mortality than non-silicosis patients. This review also established that a major occupational health problem, silicosis is

responsible for 39% of pneumoconiosis cases worldwide. Prolonged exposure to crystalline silica dust causes this chronic lung disease, which is typified by permanent pulmonary fibrosis. Chest pain, dyspnea, coughing, and expectoration of sputum are among the symptoms, which frequently result in complications such as respiratory infections.

Despite monitoring efforts, silicosis is nevertheless common, especially in industries that produce silica dust, like stone cutting, construction, and mining. Silicosis is common among mining communities in low- and middle-income nations like Zimbabwe, particularly in places like Kwekwe.

CHAPTER 3 METHODOLOGY

3.1 Introduction

Silico tuberculosis is a condition characterized by the co-existence of silicosis and tuberculosis. The research study will then retrospectively look deeper into the outcomes of silico tuberculosis, and tuberculosis patients initiated on treatment from January 2023 to 2024 in Kwekwe City and determine contributions to the outcomes as well as come up with recommendations.

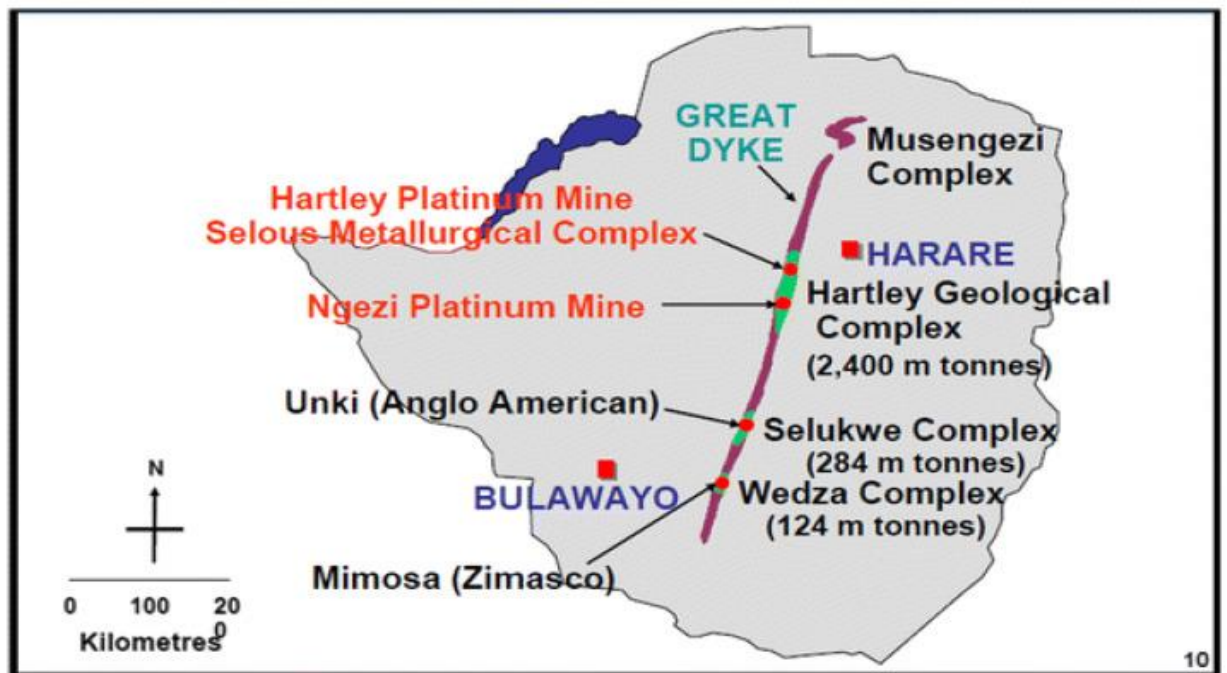


Figure 2: The Great Dyke Map

With a total of 91 administrative districts and 10 provinces, Zimbabwe is home to 15.2 million people (Zimbabwe National Statistics Agency, 2022). The vast dyke is the most common location for mining operations; it is around 550 km long and 3 to 12 km broad, as seen in the picture above. Minerals include asbestos, tin, gold, diamond, platinum, and platinum are abundant in the vast dyke. Midlands province has a hive of mining activities as it is also located along the great dyke with Kwekwe district named after the precious mineral gold as the majority of the population is known to be artisanal and mall scale miners,

3.2 The Research Design

The study is a retrospective cohort study design to determine the association of silicosis with different treatment outcomes of Tuberculosis. The study used secondary data collected from Kwekwe General Hospital and Kwekwe City Council Clinics. The key distinction lies in the approach analyzing unfavorable outcomes of both silicosis tuberculosis patients and tuberculosis patients without silicosis. This analysis focused on death, treatment failure and lost to follow up. This distinction underscores the focus on assessing distinct treatment outcomes within the context of a retrospective cohort study. The purpose of in-depth interviews was to help explore the experts' perspectives on improving treatment outcomes as well as explore tuberculosis and silicosis collaborative activities. The qualitative component of the study was founded on the constructivist paradigm of knowledge acquisition. According to this paradigm, individuals construct their own perception of the world via their experiences and viewpoints.

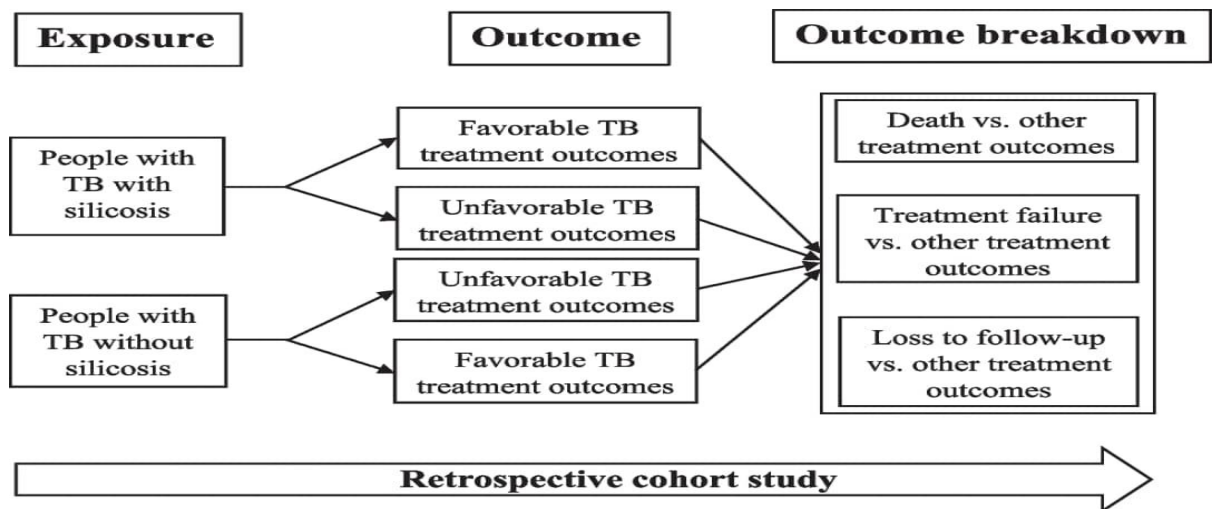


Figure 3: Study Design Schema of retrospective cohort study for predictors of mortality, treatment failure, treatment success and loss to follow up.

3.3 Population and Sampling

TB and Silico TB Patients Treatment Outcomes of patients treated in Kwekwe City between January 2022 and 2024, made up the study's quantitative population. The qualitative study population included TB focal nurses, EHTs, Doctors and Health Information Clerks working in the Tuberculosis/ Silicosis section of the health facilities within the City who were included in the in-depth interviews.

3.3.1 Purposive Sampling

Purposive Sampling was used to select the 6 health facilities in Kwekwe where these TB and Silicosis patients are served. For the purposes of this study all the health facilities have

one Environmental Practitioner each who works with the TB focal nurse in patient diagnosis, notification and contact tracing. So the EHPs are also purposively sampled to participate in the study.

3.3.2 Convenience Sampling

This sampling method was used to conveniently select TB focal nurses on duty in the TB/OI Section on the day of data collection. Two nurses per health facility were enrolled for the study.

3.4 Data Collection Instruments

Data collection instruments are the tools that researchers use to collect data in the research process. There are many types of data collection tools that researchers use. For the purposes of this study, the researcher used interview guides and the document review check list. They both have their advantages and disadvantages.

3.4.1 Interview Guides

The interview guide was used to collect data for this study. The interviews were conducted so as to gather in-depth information from major partners in the management of TB and silicosis in Kwekwe.

Alan Bryman (2008), a structured interview, sometimes called a standardized interview, entails the administration of an interview schedule by an interviewer. The aim is for all interviewees to be given exactly the same context of questioning. Alan Bryman (2008) goes on to further explain that each respondent will be able to receive exactly the same interview stimulus as any other. The goal of this style of interview is to ensure that interviewees' replies can be aggregated and this can be achieved reliably only if those replies are in response to identical cues.

3.4.2 Document Checklist

A checklist was used during document review to ensure that all the information that speaks to the research objectives is captured for further analysis. The secondary analysis of statistics from hospital records was selected for its numerous advantages to the research study. Alan Bryman (2008) explains that use of secondary data is cost and time effective. Secondary data is readily available and the data is already cleaned hence there is use of accurate information that has been verified by authorities.

3.5 Data Collection Procedure

Quantitative data was collected from the District Health Information Clerk stationed at Kwekwe General Hospital as well as from the Tuberculosis registers from the Kwekwe City Council Clinics and Male Ward Admission Registers at Kwekwe General Hospital from January 2022 to 2024. The TB registers have a record of all tuberculosis, and silico tuberculosis patients and their co infections recorded. The treatment registers contained information about any confounding variables and the treatment outcomes of the patients. The patients' treatment outcomes were compared so as to show the differences in treatment outcomes between silico-TB patients and TB patients.

Qualitative data gathering was done through in-depth interviews using an interview guide. The issues discussed were the tuberculosis treatment outcomes in both silicosis and non-silicosis patients, ways to improve tuberculosis and silicosis treatments, diagnosis and care of patients. The research participants were the tuberculosis coordinators and focal persons at each health facility. Notes were taken down during the in-depth interviews.

3.6 Analysis and Organization of Data

Chi square test analysis was performed to assess whether there is a statistically significant association between patients with silico-TB and having unfavorable treatment outcomes. This association was also assessed on TB patients without silicosis at 5% level of significance. In addition, Pearson's Chi square test statistic was also analyzed to assess if

there is an association between silicosis and death, treatment failure and loss to follow up. The statistical analysis was used to perform descriptive statistics of the demographics of the participants in the study.

3.7 Ethical Consideration

This research on silicosis and TB treatment outcomes in Kwekwe City must be ethical to safeguard participants' rights and anonymity. Clearance from AUREC was sought then permission from the Director of Health Services in Kwekwe City Council and the Medical Superintendent at Kwekwe General Hospital was also sought before commencement of data collection. Informed consent, both verbal and written was sought from all study participants. Names or identities of participants will not be used in the study.

3.8 Summary

The study's methodology was laid out in full in this chapter. Considerations of ethics in relation to the study's design, location, population, data gathering and analytic methods, and process. This was a retrospective cohort study which examined the impact of silicosis on TB treatment outcomes in Kwekwe City. The patients with a confirmed TB diagnosis and those who had silico-TB who also had available records regarding silicosis make up the study population. A comparison of treatment outcomes between the patients with TB and those with TB and silicosis was done. The study aimed to ascertain whether silicosis

negatively affects TB treatment outcomes or not. This will help guide future interventions in TB and silicosis programs.

CHAPTER 4: DATA PRESENTATION AND ANALYSIS

4.1 Introduction

The data presentation that follows details the results of silico-TB and TB treatment outcomes among people in Kwekwe City between 2022 and 2024. An extensive summary of the hospital admissions, diagnostic rates, and death data related to these common illnesses is given in this section. The information shows the effects of silicosis on TB patients as well as the difficulties in treating these illnesses.

4.2 Data Presentation, Interpretation and Analysis

Tables and graphs will be used to summarize findings on each of the attributes that were assessed in this research.

4.2.1 Demographics of participants

Table 1: Demographics of participants

Variable	Categories	Total number(n)	Percentage(%)
Sex	Male	5	35.7
	Female	9	64.3
Designation	Nurse	5	35.7
	EHT	5	35.7
	HIC	1	7.1

	TB Coordinator	2	12.3
	Microscopist	1	7.1
Years in Service	Median	years	in
	Service = 6-3	divided	
	by 2 plus 3	=4.5	years
Age	Median	age=65-	
	35	divided by 2 plus	
	35	=45	years

A total of 14 participants were enrolled in the study. 35.7% were males while 57.1% were females. 5 nurses were the TB Focal nurses at the clinics while the other 5 were the Environmental Health Technicians from the clinics. 2 were the TB Coordinators from both City Council and Government and the Microscopist as well as the Health Information Clerk. The median years of health workers in service was 4.5 years while the median age of health workers was 45 years.

4.2.2. Targeted TB and Silicosis Outreach Screening by Kunda Nqobi' TB

In 2022, 475 individuals were screened of which 13 (2.74%) were diagnosed with TB whilst 41 (8.63%) were diagnosed with silicosis. In 2023, 536 individuals were screened in which 5 (0.93%) were diagnosed with TB whilst 80 (14.93%) were diagnosed with

silicosis. In 2024, 1386 individuals were screened in which 13 (0.94%) were diagnosed with TB whilst 291 (20.10%) were diagnosed with silicosis and 5 (0.36%) were diagnosed with silico-Tb. The table below summarizes these findings.

Table 2 : Kunda Nqobi TB Outreach Screening

Attributes	Year			
	2022	2023	2024	Total
Number Screened	475	536	1386	2397
Number Diagnosed with TB	13	5	13	31
Number Diagnosed with Silicosis	41	80	291	412
Number Diagnosed with Silico-TB	0	0	5	5

4.2.3. Kwekwe General Hospital Male Ward TB, Silicosis and Silico TB Admissions

From 2022 to 2024, 165 TB patients were admitted at Kwekwe general hospital, male ward. Moreso, 46 (27.88%) deaths were recorded from these patients whilst 119 (72.12%) patients were discharged. In the same period 45 silico-TB patients were admitted at Kwekwe general hospital in which 13 (28.89%) of these patients died while 32 (71.11%)

were discharged. 27 silicosis patients were admitted at the same hospital between 2022 and 2024. 7 (25.93%) deaths were recorded from the 27 silicosis patients whilst 20 (74.07%) individuals were discharged. The following graph illustrates this data.

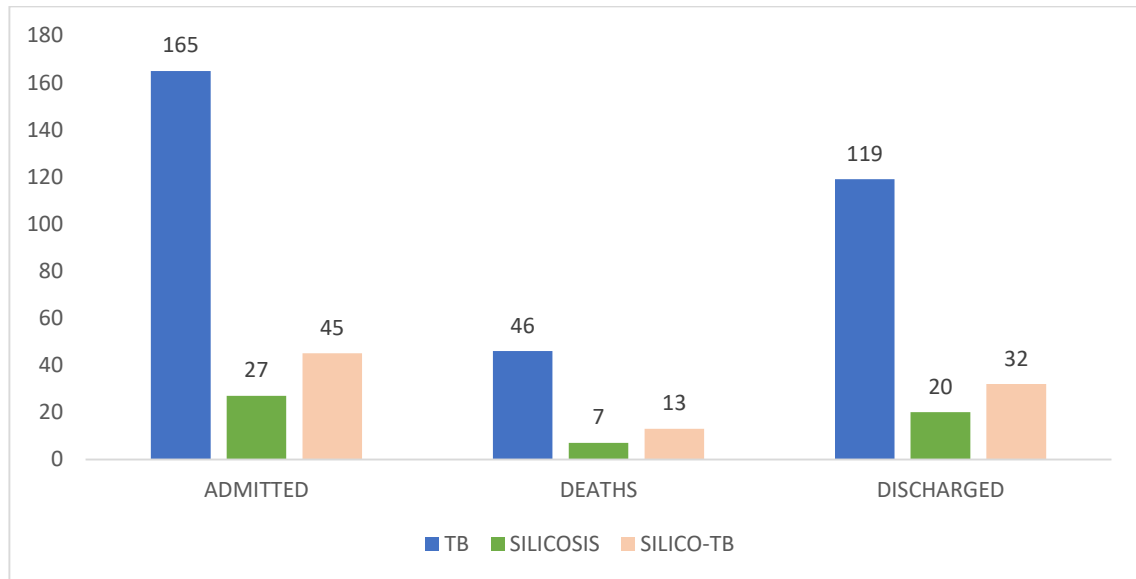


Figure 4: Kwekwe General Hospital TB, Silicosis, Silico TB Admissions

4.2.4 Community TB Report by TB Focal Nurse

The TB Focal nurse and community follow up report highlighted that there were 46 Male silico- TB cases and 10 silico-TB deaths recorded in the community from 2022 to 2024. Furthermore, 74 Male silicosis cases and 22 silicosis deaths were recorded in the community during 2022 to 2024 period.

4.2.5 Kwekwe City Council TB Registers 2022 to 2024

Kwekwe city clinics recorded 695 completed TB treatment and 6 Males completed silico-Tb treatment. 65 TB deaths and 2 silico-TB deaths were recorded at the same clinics. In addition, 48 TB cases were not evaluated while 3 Male silico-TB cases were also not evaluated. No silicosis death or treatment completion was found. Moreover, no female or childhood silicosis cases recorded or found in Kwekwe city and this information is illustrated in fig below.

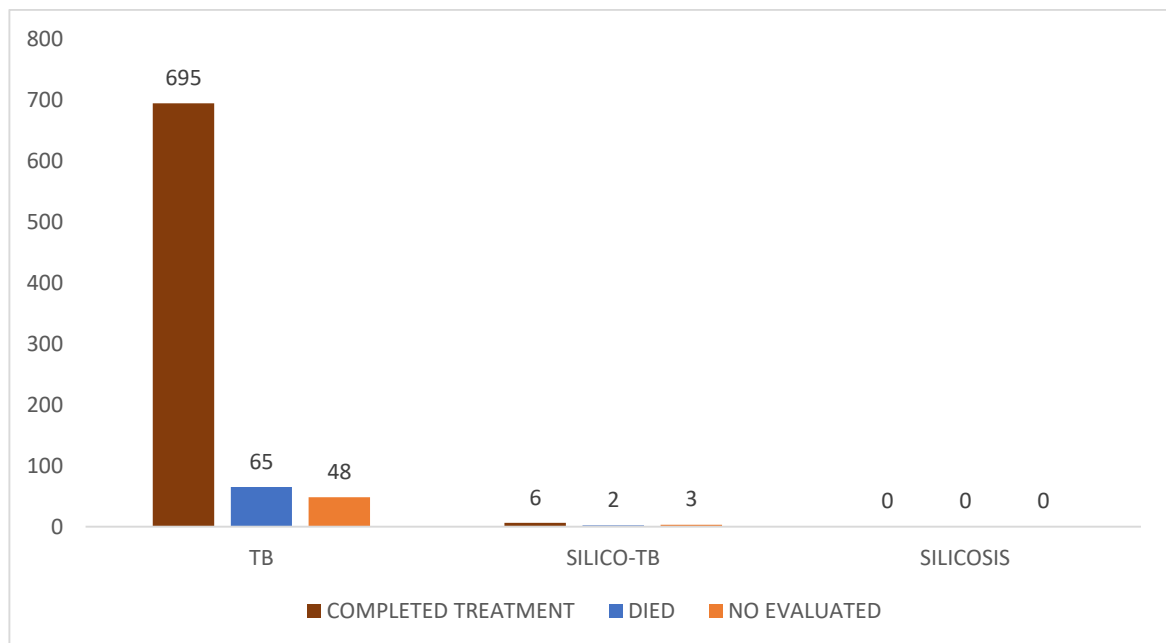


Figure 5: Kwekwe City Council Clinics TB Registers

4.3 Discussion and Interpretation

In this secondary analysis of data, a total of 819 TB patients in the Kwekwe City Council Clinics TB Registers was reviewed. No silicosis patients were registered during the period

under review. 84.9% TB treatment success was recorded during the period under review, 0.8% TB death rate was recorded and 5.9% rate of Not Evaluated patients. There were recorded treatment fail rates in Kwekwe City. All the patients were monitored at a health facility by trained nurses and EHPs and in the community by trained community health workers. 11 silico-TB patients were recorded and 6 of them completed treatment bringing the treatment success rate to 54.5% while 2 died bringing the death rate to 18% and 3 (27.2%) were not evaluated.

The data presented shows that the death rate of silico-tb patients is quite high and there is need to intensify TB testing among silicosis patients so as to offer relevant treatments early. Due to poor follow ups and incomplete records, the researcher therefore could not conclude the fate of the 3 un evaluated silico-TB cases and the 48 unevaluated TB cases. All the research participants agreed to the fact that silicosis itself makes a patient susceptible to TB and considering the poor health seeking behavior of the most affected community of artisanal miners, it becomes difficult to help treat TB in silicosis patients who come to the clinic with advanced stages of silicosis as well as TB. The numbers of unevaluated patients are also very high and this is attributed to either incomplete records or to the fact that the artisanal miners are migratory hence sometimes move from one mine to another without informing the clinic and end up defaulting treatment or completing treatment in another district.

Kwekwe city council does not have a record of many silico-TB and silicosis cases because it has no facility to screen and diagnose silicosis. These patients are usually diagnosed at Gweru Provincial hospital or during outreach programs by Baines Occupational Clinic. A few who are recorded in Kwekwe City Clinics will be referrals from Gweru Provincial

Hospital. The rest of them are treated at Kwekwe General Hospital where those in need of oxygen are admitted and treated until they are discharged of which most of the silicosis patients are given an oxygen tank to take home if they have become oxygen dependent.

Kwekwe General Hospital Male Ward recorded a total of 165 TB patients which yielded a 71.2% treatment success rate and a 27.9% death rate which were quite higher than the recommended standards. 45 silico-TB patients were admitted during the period under review. 13 died while admitted at the hospital while 10 died after being discharged from hospital. The treatment success rate was 48.9% and the death rate was 51.1%. These were very poor outcomes which show how bad silicosis can affect TB treatment outcomes. The differences in treatment outcomes clearly show that silicosis negatively impacts TB treatment as patients have an impaired immune system specifically the respiratory system.

The data from targeted silicosis and TB screening amongst artisanal miners has given the researcher a clear picture of the prevalence of silicosis and TB among artisanal miners. 2397 clients were screened and 412 were diagnosed with silicosis, 31 with TB and 5 with silico-TB. A notable increase in diagnosis of all conditions was seen in 2024 with the first 5 silico-TB cases being recorded from the outreach teams. The challenge is however noted when people are diagnosed with silicosis in the field but there is no record or any follow ups from local clinic. The assumption is that these silicosis patients are the ones who report to the hospital late and in dire need of oxygen. The mining community's health seeking behavior is quite poor hence it is possible that rumors on social media of too many undocumented silicosis and silico-TB community deaths are true.

All the records that were reviewed clearly show that the silicosis burden is high in Kwekwe and the most affected are the male artisanal miners. The same are also at risk of

developing tuberculosis even though most of the silicosis patients have no proper documentation at local clinics. It is also of great importance to have all TB patients screened for silicosis when they are diagnosed so as to monitor if they are diagnosed with silicosis while taking TB medicines. It is also important to ensure that all those diagnosed with silicosis are screened regularly for TB and also are initiated on TPT.

4.4 Summary

In the Kwekwe City Context, this study has clearly shown how Kwekwe City is sitting on a time bomb before an outbreak of silico-TB cases with poor treatment outcomes if this problem is not handled properly. The prevalence of silicosis is very high as evidenced by the increased number of diagnosed cases in the city. The death rate of silicosis is also quite high given the statistics in the Hospital records as well as social media reports. The same silicosis patients become vulnerable to TB given their occupational exposures. The artisanal miners are known for their poor health seeking behaviors while they work in areas that expose them to TB and silicosis where there is no access to health care. It is therefore concluded by this study in the Kwekwe City Context that silicosis has a negative impact on TB treatment outcomes.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This Chapter will give a summery, conclusions and recommendations for the study on the impact of silicosis on TB treatment outcomes in Kwekwe City. The recommendations will be used to address the problems that have been identified in the TB and Silicosis Program so as to give the best services to the patients.

5.2 Discussion

This study analyzed data for 165 Male TB, 27 Silico-TB and 45 Silicosis Patients admitted at Kwekwe General Hospital Male Ward, 2397 Male Artisanal Miners Screened at their work stations, 74 Silicosis and 47 Silico-TB observed at community level and All the 817 TB Patients and 11 silico-tb patients in the Kwekwe City TB Registers.

A major public health concern is the interaction between silicosis and tuberculosis (TB), especially in industrial areas such as Kwekwe City in Zimbabwe's Midlands Province. In order to comprehend the effects of silicosis on TB treatment results, this essay examines data gathered between 2022 and 2024, paying particular attention to diagnostic rates, mortality, treatment success, and follow-up rates.

The data gathered from Kwekwe City between 2022 and 2024 shows notable patterns in the detection and screening of silicosis and TB especially among males who are artisanal miners, underscoring the difficulties in treating these interrelated medical conditions. Alongside varying TB diagnosis rates, the rising incidence of silicosis raises significant

concerns regarding screening procedures, public health regulations, and the underlying causes of these patterns.

A comparatively low TB diagnosis rate of 2.74% (13 cases) and a silicosis diagnosis rate of 8.63% (41 cases) were obtained from the targeted outreach screening of 475 people in 2022. However, the data showed a concerning rise in silicosis cases when screening efforts stepped up in the years that followed. Although 536 people had been examined by 2023, the rate of TB diagnoses fell precipitously to 0.93% (5 instances). On the other hand, the diagnosis rate of silicosis increased to 14.93% (80 cases). This pattern clearly indicates a decrease in TB disease prevalence which is in line with the findings of Chipunduro et al. (2022). Chipunduro et al. (2022) opined that TB prevalence has decreased relative to prior estimates, possibly as a result of the increased antiretroviral therapy coverage and successful national TB control strategies. By 2024, the targeted screening of silicosis increased significantly to 1,386 people, resulting in a startling 291 instances of silicosis (20.10%) and 13 TB diagnoses (0.94%).

A study conducted by Moyo et al. (2024) provided similar results in which the instances of silicosis among ASMs in Zimbabwe. Concerns over occupational exposure in the population are raised by this notable increase in silicosis diagnoses, especially for those employed in mining or other silica-exposing industries (Moyo et al., 2024). Consequently, the varying TB diagnosis rates over the course of the three years highlight how difficult it is to manage TB when silicosis is present. Although the number of TB diagnoses was higher in the early years, 2023 and 2024 both had significantly lower rates which were 0.93% and 0.94%, respectively. This can be attributed to lower rates of transmission which could have resulted from successful TB control strategies, such as public health initiatives.

5.2.1 Death Rate Assessment

The substantial impact of silicosis on TB treatment outcomes is reflected in the extremely high death rates among Tb and silico-TB patients in Kwekwe city. Thirteen of the 45 silico-TB patients who were admitted at Kwekwe General Hospital between 2022 and 2024 died, yielding a 28.9% mortality rate on admitted patients. The number which then increased with 10 more community deaths from the discharged silico-TB patients bringing the death rate to 51.1% and a treatment success rate of 49.1%. In addition, 27.9% of the 165 TB patients who were admitted at Kwekwe general hospital died. This shows a slight increase in the percentage of the mortality rate of TB patients while silico-TB deaths are high which suggests that silicosis presents serious dangers to the health of TB patients thus increasing their odds of mortality. Records from Kwekwe City Council Clinics showed a 0.8% death rate from TB cases while there was an 18% death rate from Silico-TB.

These results were identical to the findings in Masvingo in which a 27.3% TB death rate was recorded. Furthermore, similar TB death rates of 30% and 26.1% were also recorded in Matabeleland South and Matabeleland North provinces respectively (Mando et al., 2023). A study by Rupani et al. (2023) also highlighted that silicosis patients are four to six times more likely to die from TB-related complications compared to those without silicosis. Consequently, the co-occurrence of these disorders makes health issues worse since silicosis patients frequently have impaired lung function, which increases their vulnerability to serious tuberculosis infections (Rupani and Soundararajan, 2024). These numbers are in line with research from other areas where silicosis has been demonstrated

to increase the mortality rate from tuberculosis. A study conducted in South Africa, for example, found that silicosis doubles the risk of TB-related death, with patients with both illnesses having a two times higher chance of dying than those with TB alone (Waternaud et al., 2006).

Furthermore, according to the follow-up reports, 10 patients died from silico-TB after being discharged from the hospital, and 22 deaths were reported from silicosis patients. This implies that a higher silicosis and silico-TB death rate may have resulted from many patients not receiving proper care or follow-up following their initial therapy. Silicosis patients are mostly dependent on piped oxygen in the hospital. When stabilized, they are given an oxygen concentrator to use at home but most of them die because of reported power cuts and inappropriate use. The high fatality rates underscore the pressing need for increased access to healthcare services in mining towns where silicosis and tuberculosis are common, as well as for better management strategies for individuals with these disorders co-occurring.

During the period under review, there were 27 silicosis patients admitted, and 7 of them died, a mortality rate of 25.93%. Many of these oxygen dependent silicosis patients die after hospital discharge. Despite being marginally lower than those for silico-TB and TB, this number nevertheless indicates a substantial burden. As a result, since silicosis is a chronic and progressive illness that can deteriorate lung function and increase susceptibility to respiratory infections, its fatality rates are high. Furthermore, patient outcomes are made more difficult by the dearth of efficient silicosis treatment choices, which mostly concentrate on symptom alleviation and preventing additional exposure (Ehrlich et al., 2021).

5.2.2 Treatment Success Outcomes

Significant differences in the TB and silico-tb treatment outcomes in Kwekwe City demonstrate the efficacy and accessibility of available treatments for these illnesses. Based on Kwekwe City Clinics TB Registers statistics, Kwekwe City's TB treatment success rates were determined. The success rate for silico-TB patients was 54.5%, whereas it was 84.9% for TB patients. Kwekwe General Hospital had a treatment success rate of 72.1% and while silico-TB treatment success rate was at 48.9%. This result is almost similar to an analysis of TB treatment outcomes done in Matabeleland South Province which had a TB treatment success rate of 77.3% (Mando et al., 2023) which is below expected National TB Program Targets of 90% treatment success rates.

The fact that these rates fall short of the 90% national goal for TB treatment success suggests that improved patient support networks and treatment approaches are required. Research has indicated that silicosis has a substantial effect on treatment results; patients with both illnesses frequently have worse health and a higher treatment failure rate. Treatment becomes more difficult when silicosis and TB coexist because silicosis might enhance a person's vulnerability to TB and raise the chance of treatment failure. Therefore, enhancing overall treatment success rates requires attending to the unique demands of silico-TB patients. This can be attributed to the implementation

of successful treatment protocols like the Directly Observed Treatment, Short-course (DOTS) method. Moreover, this can also be attributed to the enhancement of patient adherence which could have also been made possible by community health programs.

5.2.3 Loss to Follow-Up Rate

In Kwekwe City, a major problem influencing treatment results is loss to follow-up. 48 TB cases were not examined, according to the statistics, which translates to a lost to follow-up rate of roughly 5.9%. This lost to follow-up rate was low compared to the one obtained in a study conducted by Murangozvombo et al. (2019) in which 12% rate was obtained. This result is encouraging as it shows an improvement in the health sector in as much as the rate of loss to follow-up is concerned. With only three (27.2%) instances not examined, the loss for silico-TB was negligible. Since patients who discontinue treatment are more likely to develop drug-resistant TB and suffer negative health consequences, high rates of loss to follow-up can significantly reduce the efficacy of TB reduction initiatives. According to research, artisanal miners' movement, the stigma attached to tuberculosis, and the lack of access to quality treatment in rural areas are some of the variables that lead to loss to follow-up. Improving patient retention in treatment programs and guaranteeing that people receive the care they require for both silicosis and tuberculosis depend on removing these obstacles.

5.3 Conclusions

In conclusion, the substantial influence of silicosis on TB treatment results is demonstrated by the examination of Kwekwe City's death rates, treatment failure rates, success rates, and loss to follow-up. The need for focused interventions and better access to healthcare for impacted communities is highlighted by the high death rates and treatment failures. To address the intricate interactions between silicosis and tuberculosis and eventually

improve health outcomes for these susceptible populations, further study and specialized approaches are needed. Silicosis has a negative impact on TB treatment outcomes as evidenced by the statistics gathered during this study.

5.4 Implications

While TB treatment outcomes have significantly improved, it is important to continue screening artisanal miners for both TB and Silicosis and help them understand the importance of seeking for treatment early. It is also important to understand the relationship that exists between TB and silicosis especially amongst artisanal miners given their occupational exposures.

A mining town such as Kwekwe, with no healthcare services based at the mining areas has a lot of health problems that remain unknown until they present as complicated cases at the health centers. The increased number of silicosis cases poses a risk of silico-TB hence preventive measures need to be intensified. The major implication is that the system will soon be overburdened by silicosis and silico-TB patients if the situation will not be sustainable. Currently, silicosis and silico-TB patients who are oxygen dependent are put on piped oxygen at Kwekwe General Hospital. Upon discharge, they are given an oxygen concentrator for use. It is only until one patient dies that the next recipient is able to get the oxygen concentrator and be discharged from hospital. A situation that is quite expensive for the Ministry of Health at large. This shows how important it is for patients to seek for treatment early and prevent such complications.

5.5 Recommendations

Better screening procedures are required, as evidenced by Kwekwe's trends in diagnosis and screening. Given the increase in silicosis cases, healthcare professionals ought to put in place improved screening procedures that particularly target the dangers of occupational exposure. This might entail routine health examinations for workers in high-risk settings and making sure TB /Silicosis testing is a component of the standard evaluation for patients with TB/silicosis.

Healthcare professionals may help people with silicosis and tuberculosis achieve better health outcomes by tackling these issues, which will ultimately lead to a healthier community. In this area, silicosis and tuberculosis are two diseases that must be addressed with increased awareness, education, and integrated screening methods.

The examination of Kwekwe City's mortality rates and treatment results highlights the urgent need for integrated healthcare approaches to address the problems caused by silicosis and tuberculosis. For both illnesses, the high death rates emphasize the significance of prompt diagnosis, efficient treatment, and ongoing follow-up care. Furthermore, the disparity in treatment results between silico-TB and TB highlights the need for targeted interventions that improve care access, especially for patients with silicosis who encounter major obstacles.

Public health programs must place a high priority on education, awareness, and access to complete healthcare services in order to enhance patient outcomes. By tackling these issues, we may try to lower death rates and enhance treatment outcomes for people in

Kwekwe City who have silicosis and tuberculosis. The community can get closer to overcoming the combined burden of these severe medical diseases with such measures.

There is need for documentation and follow up of silicosis patients diagnosed during outreach programs so as to continue screening them for tuberculosis and assess for silicosis progression while offering health education on silicosis control.

While all participants were trained, it is also important to establish a system for ongoing training and refresher courses to keep healthcare workers updated on best practices, new protocols, and emerging trends in TB and Silicosis management.

Furthermore, in order to lessen the dependence on paper forms, the procedures for entering data into EHR and ODK must be optimized and this transition can be made easier by providing clear guidelines and support to all health workers hence patient data is saved and updated in a more secure way.

It also imperative to enhance communication and feedback mechanisms by ensuring that public health officials and healthcare facilities communicate on a regular basis to exchange information about TB and Silicosis including successful and unsuccessful initiatives. Subsequently, this may improve the quality of data as well as the team work between health facilities and community health workers. Especially Baines Occupational Health Teams, Gweru General Hospital Occupational Health Clinic and Kwekwe City Health Facilities and their Community Based Organizations dealing with TB and Silicosis issues at community level. Their collaboration will help improve patient follow up and patient treatment outcomes.

It is also of great importance to improve and equip the clinic with the latest equipment and machines for TB and Silicosis Screening and Diagnosis.

5.6 Suggestions for Further Research

There is need to do studies on how best oxygen dependent silicosis patients can be assisted with some portable breathing aids so that they can continue working.

LIST OF REFERENCES

- Albadrani M. (2023). Exploring the Impact of Silicosis Incidence on Tuberculosis Mortality and Morbidity: A Multi-Country Study. *Medical sciences (Basel, Switzerland)*, 11(4), 63. <https://doi.org/10.3390/medsci11040063>.
- Anna, H., Alecksander B. & Marcin, S. (2018). Pulmonary Tuberculosis in a Male with Silicosis. Wielkopolskie Centre of Pulmonology and Thoracic Surgery, Ludwikowo, k/Ponania, 62050 Mosina, Poland.
- Chadambuka, A., Mabaera, B., Tshimanga, M., Shambira, G., Gombe, N. T., & Chimusoro, A. (2011). Low tuberculosis case detection in Gokwe North and South, Zimbabwe in 2006. *African health sciences*, 11(2), 190–196.
- Chakaya, J., Khan, M., Ntoumi, F., Aklillu, E., Fatima, R., Mwaba, P., Kapata, N., Mfinanga, S., Hasnain, S. E., Katoto, P. D. M. C., Bulabula, A. N. H., Sam-Agudu, N. A., Nachega, J. B., Tiberi, S., McHugh, T. D., Abubakar, I., & Zumla, A. (2021). Global Tuberculosis Report 2020 - Reflections on the Global TB burden, treatment and prevention efforts. *International journal of infectious diseases: IJID: official publication of the International Society for Infectious Diseases*, 113 Suppl 1(Suppl 1), S7–S12. <https://doi.org/10.1016/j.ijid.2021.02.107>
- Chaudhury, N., Phatak, A., Paliwal, R., & Raichaudhari, C. (2010). Silicosis among agate workers at Shakarpur: An analysis of clinic-based data. *Lung India: official organ of Indian Chest Society*, 27(4), 221–224. <https://doi.org/10.4103/0970-2113.71955>

- Chipinduro, M., Timire, C., Chirenda, J., Matambo, R., Munemo, E., Makamure, B., Nhidza, A. F., Tinago, W., Chikwasha, V., Ngwenya, M., Mutsvangwa, J., Metcalfe, J. Z., & Sandy, C. (2022). TB prevalence in Zimbabwe: a national cross-sectional survey, 2014. *The international journal of tuberculosis and lung disease: the official journal of the International Union against Tuberculosis and Lung Disease*, 26(1), 57–64. <https://doi.org/10.5588/ijtld.21.0341>
- Cowie R. L. (1994). The epidemiology of tuberculosis in gold miners with silicosis. *American journal of respiratory and critical care medicine*, 150(5 Pt 1), 1460–1462. <https://doi.org/10.1164/ajrccm.150.5.7952577>
- E. Hnizdo, J. Murray. Risk of pulmonary tuberculosis relative to silicosis and exposure to silica dust in South African goldminers. *Occupational Environmental Medicine*, 55 (1998), pp. 496-502, [10.1136/oem.55.7.496](https://doi.org/10.1136/oem.55.7.496)
- Ehrlich, R., Akugizibwe, P., Siegfried, N. et al. The association between silica exposure, silicosis and tuberculosis: a systematic review and meta-analysis. *BMC Public Health* 21, 953 (2021). <https://doi.org/10.1186/s12889-021-10711-1>
- Farazi, A., & Jabbariasl, M. (2015). Silico-tuberculosis and associated risk factors in central province of Iran. *The Pan African medical journal*, 20, 333. <https://doi.org/10.11604/pamj.2015.20.333.4993>
- Floyd, K., Glaziou, P., Houben, R. M. G. J., Sumner, T., White, R. G., & Raviglione, M. (2018). Global tuberculosis targets and milestones set for 2016-2035: definition and rationale. *The international journal of tuberculosis and lung disease: the*

official journal of the International Union against Tuberculosis and Lung Disease, 22(7), 723–730. <https://doi.org/10.5588/ijtld.17.0835>

Gabida, M., Tshimanga, M., Chemhuru, M., Gombe, N & Bangure, D.(2015). Trends for Tuberculosis Treatment Outcomes, New Sputum Smear Positive Patients in Kwekwe District, Zimbabwe, 2007-2011: A Cohort Analysis. *Journal of Tuberculosis Research*, Vol.3 No.4

Girdler-Brown, B. V., White, N. W., Ehrlich, R. I., & Churchyard, G. J. (2008). The burden of silicosis, pulmonary tuberculosis and COPD among former Basotho goldminers. *American journal of industrial medicine*, 51(9), 640–647. <https://doi.org/10.1002/ajim.20602>

Global TB Report Zimbabwe Country Profile, 2023. 2023. Retrieved from: https://worldhealthorg.shinyapps.io/tb_profiles/?_inputs_&entity_type=%22country%22&iso2=%22ZW%22&lan=%22EN%22

Harries, A.D., Nyirenda, T.E., Banerjee, A., Boeree, M.J. and Salaniponi, F.M. (1999) Treatment Outcome of Patients with Smear-Negative and Smear-Positive Pulmonary Tuberculosis in the National Tuberculosis Control Programme, Malawi. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 4, 443-446. [http://dx.doi.org/10.1016/S0035-9203\(99\)90153-0](http://dx.doi.org/10.1016/S0035-9203(99)90153-0)

Hnizdo, E., & Murray, J. (1998). Risk of pulmonary tuberculosis relative to silicosis and exposure to silica dust in South African gold miners. *Occupational and environmental medicine*, 55(7), 496–502. <https://doi.org/10.1136/oem.55.7.496>

<http://uzt.org.zw>

- Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF) IISD; Winnipeg: 2018. Global trends in artisanal and small-scale mining (ASM): a review of key numbers and issues. [[Google Scholar](#)][[Ref list](#)]
- Jiang, Y., Chen, J., Ying, M., Liu, L., Li, M., Lu, S., Li, Z., Zhang, P., Xie, Q., Liu, X., & Lu, H. (2023). Factors associated with *loss to follow-up* before and after treatment initiation among patients with tuberculosis: A 5-year observation in China. *Frontiers in medicine*, 10, 1136094. <https://doi.org/10.3389/fmed.2023.1136094>
- Knight, D., Ehrlich, R. & Cois, A. Predictors of silicosis and variation in prevalence across mines among employed gold miners in South Africa. *BMC Public Health* **20**, 829 (2020). <https://doi.org/10.1186/s12889-020-08876->
- Leung, C. C., Yu, I. T., & Chen, W. (2012). Silicosis. *Lancet (London, England)*, 379(9830), 2008–2018. [https://doi.org/10.1016/S0140-6736\(12\)60235-9](https://doi.org/10.1016/S0140-6736(12)60235-9)
- Liu, X., Jiang, Q., Wu, P., Han, L., & Zhou, P. (2023). Global incidence, prevalence and disease burden of silicosis: 30 years' overview and forecasted trends. *BMC public health*, 23(1), 1366. <https://doi.org/10.1186/s12889-023-16295-2>
- Luck, J., Chang, C., Brown, E.R. & Lumpkin, J.(2006). Using Local Health Information To Promote Public Health: Issues, barriers, and proposed solutions to improve information flow. *Health Affairs* 25(4):979-91, DOI: [10.1377/hlthaff.25.4.979](https://doi.org/10.1377/hlthaff.25.4.979)
- Magoronga, M. (2024). Silicosis claims 12 lives in Kwekwe. Sunday mail. Retrieved from <https://www.chronicle.co.zw/silicosis-claims-12-lives-in-kwekwe/>

- Mando, T. C., Sandy, C., Chadambuka, A., Gombe, N. T., Juru, T. P., Shambira, G., Umeokonkwo, C. D., & Tshimanga, M. (2023). Tuberculosis cohort analysis in Zimbabwe: The need to strengthen patient follow-up throughout the tuberculosis care cascade. *PloS one*, 18(11), e0293867. <https://doi.org/10.1371/journal.pone.0293867>
- Mbuya, A.W.; Mboya, I.B.; Semvua, H.H.; Mamuya, S.H.; Msuya, S.E. Prevalence and factors associated with tuberculosis among the mining communities in Mererani, Tanzania. *PLoS ONE* 2023, 18, e0280396. [[Google Scholar](#)]
- Mihir P. (2023). A Mixed-Methods study on the Impact of Silicosis on Tuberculosis Treatment Outcomes and Need for Tuberculosis-Silicosis Collaborative Activities in India. National Library of Medicine.
- Ministry of Health and Child Care. Zimbabwe National Tuberculosis and Leprosy Guidelines 2023; Ministry of Health and Child Care: Harare, Zimbabwe, 2023. [[Google Scholar](#)]
- MOHCC. Ministry of Health and Child Care National Tuberculosis Program–Strategic Plan (2021–2025). 2020
- Moyo D, Kavenga F, Ncube RT, Moyo F, Chiboyiwa N, Nyambo A, Madziva G, Ncube M, Muzvidziwa O, Mperi T, et al. Treatment Outcomes of Tuberculosis Among Artisanal and Small-Scale Miners in Zimbabwe: A Follow-Up Observational Study Using Secondary Data. *International Journal of Environmental Research and Public Health*. 2024; 21(10):1282. <https://doi.org/10.3390/ijerph21101282>

- Moyo, D., Ncube, R., Kavenga, F., Chikwava, L., Mapuranga, T., Chiboyiwa, N., Chimunhu, C., Mudzingwa, F., Muzvidziwa, O., Ncube, P., Mando, T. C., Moyo, F., Chigaraza, B., Masvingo, H., & Timire, C. (2022). The Triple Burden of Tuberculosis, Human Immunodeficiency Virus and Silicosis among Artisanal and Small-Scale Miners in Zimbabwe. *International journal of environmental research and public health*, 19(21), 13822. <https://doi.org/10.3390/ijerph192113822>
- Moyo, D.; Moyo, F.; Kavenga, F.; Muzvidziwa, O.; Madziva, G.; Chigaraza, B.; Ncube, M.; Madadangoma, P.; Masvingo, H; Muperi, T.; Mando, T. and Ncube, R. (2024). Health Screening Strategies for Artisanal and Small Scale Miners for Tuberculosis, HIV and Silicosis: A Case of USAID-Supported Kunda Nqobi'TB Project in Zimbabwe
- Moyo, D.; Ncube, F.; Kavenga, F.; Chikwava, L.; Mapuranga, T.; Chiboyiwa, T.; Chimunhu, C.; Mudzingwa, O.; Ncube, P; (2021). Tuberculosis and Silicosis Burden in Artisanal and Small Scale Gold Miners in a large Occupational Health Outreach Programme in Zimbabwe
- Moyo, D.; Ncube, R.; Kavenga, F.; Chikwava, L.; Mapuranga, T.; Chiboyiwa, N.; Chimunhu, C.; Mudzingwa, F.; Muzvidziwa, O.; Ncube, P.; et al. The Triple Burden of Tuberculosis, Human Immunodeficiency Virus and Silicosis among Artisanal and Small-Scale Miners in Zimbabwe. *Int. J. Environ. Res. Public Health* 2022, 19, 13822. [Google Scholar] [CrossRef]

- Murongazvombo, A. S., Dlodlo, R. A., Shewade, H. D., Robertson, V., Hirao, S., Pikira, E., Zhanero, C., Taruvinga, R. K., Andifasi, P., & Tshuma, C. (2019). Where, when, and how many tuberculosis patients are lost from presumption until treatment initiation? A step by step assessment in a rural district in Zimbabwe. *International journal of infectious diseases: IJID: official publication of the International Society for Infectious Diseases*, 78, 113–120. <https://doi.org/10.1016/j.ijid.2018.10.013>
- Murray, J., Davies, T., & Rees, D. (2011). Occupational lung disease in the South African mining industry: research and policy implementation. *Journal of public health policy*, 32 Suppl 1, S65–S79. <https://doi.org/10.1057/jphp.2011.25>
- Naude, J.M., R.I. Ehrlich, G.J. Churchyard, L. Pemba, K. Dekker, M. Vermeis, *et al.* Tuberculosis and silica exposure in South African gold miners. *Occupational Environmental Medicine*, 63 (2006), pp. 187-192, [10.1136/oem.2004.018614](https://doi.org/10.1136/oem.2004.018614)
- P. Jamshidi, B. Danaei, M. Arbabi, B. Mohammadzadeh, F. Khelghati, A. Akbari Aghababa, A. Nayebeza, A.H. Shahidi Bonjar, R. Centis, G. Sotgiu, M.J. Nasiri, G.B. Migliori. Silicosis and tuberculosis: A systematic review and meta-analysis, *Pulmonology*, 2023. ISSN 2531-0437. <https://doi.org/10.1016/j.pulmoe.2023.05.001>
- PACT. (2015). *A Golden Opportunity: A Scoping Study of Artisanal and Small Scale Gold Mining in Zimbabwe*, PACT: Washington, DC, USA.

- Paul, B., & Chounwou T. (2022). The Tipple Burden of Tuberculosis, Human Immunodeficiency Virus and Silicosis among Artisanal and Small-Scale Miners in Zimbabwe.
- Rees, D. & Murray, J. (2007). Silica, Silicosis and Tuberculosis. National Institute for Occupational Health. Johannesburg, South Africa.
- Rupani M. P. (2023). A mixed-methods study on impact of silicosis on tuberculosis treatment outcomes and need for TB-silicosis collaborative activities in India. *Scientific reports*, 13(1), 2785. <https://doi.org/10.1038/s41598-023-30012-4>
- Rupani, M.P. (2023). Silicosis as a predictor of tuberculosis mortality and treatment failure and need for incorporation in differentiated TB care models in India. *Arch Public Health* **81**, 173 <https://doi.org/10.1186/s13690-023-01189-x>
- Rupani, M.P., Nimavat, P., Patel, Y. et al. Framework for implementing collaborative TB-silicosis activities in India: insights from an expert panel. *Arch Public Health* 82, 91 (2024). <https://doi.org/10.1186/s13690-024-01325-1>
- Schwartz, F.W.; Lee, S.; Darrah, TH. (2021). A review of the Scope of Artisanal and Small Scale Mining Worldwide, Poverty, and the Associated Health Impacts. *GeoHealth* 2021, 5, e2020GH000325. [Google Scholar]
- Sharma, N., Kundu, D., Dhaked, S., & Das, A. (2016). Silicosis and silicotuberculosis in India. *Bulletin of the World Health Organization*, 94(10), 777–778. <https://doi.org/10.2471/BLT.15.163550>

- Sharma, S., Nayak, S., Bhavani, R. & Singh, K. (2024). Silico-tuberculosis: An updated review. *Indian Journal of Tuberculosis*
<https://doi.org/10.1016/j.ijtb.2024.01.005>
- Sinha, R., Priya, A., & Ahmad, A. (2023). Risk of Silico-Tuberculosis in Miners: A Systematic Review and Meta-Analysis. *Indian journal of occupational and environmental medicine*, 27(4), 296–302.
https://doi.org/10.4103/ijoen.ijoen_287_22
- Soedarsono, S., Mertaniasih, N. M., Kusmiati, T., Permatasari, A., Juliasih, N. N., Hadi, C., & Alfian, I. N. (2021). Determinant factors for loss to follow-up in drug-resistant tuberculosis patients: the importance of psycho-social and economic aspects. *BMC pulmonary medicine*, 21(1), 360.
<https://doi.org/10.1186/s12890-021-01735-9>
- Sulis, G., Roggi, A., Matteelli, A., & Raviglione, M. C. (2014). Tuberculosis: epidemiology and control. *Mediterranean journal of hematology and infectious diseases*, 6(1), e2014070. <https://doi.org/10.4084/MJHID.2014.070>
- Takarinda, K. C., Harries, A. D., Sandy, C., Mutasa-Apollo, T., & Zishiri, C. (2016). Declining tuberculosis case notification rates with the scale-up of antiretroviral therapy in Zimbabwe. *Public health action*, 6(3), 164–168.
<https://doi.org/10.5588/pha.16.0029>
- teWaternaude, J. M., Ehrlich, R. I., Churchyard, G. J., Pemba, L., Dekker, K., Vermeis, M., White, N. W., Thompson, M. L., & Myers, J. E. (2006). Tuberculosis and

silica exposure in South African gold miners. *Occupational and environmental medicine*, 63(3), 187–192. <https://doi.org/10.1136/oem.2004.018614>

The Union Zimbabwe Trust. Kunda Nqobi’TB Program in Zimbabwe; The Union Zimbabwe Trust: Harare, Zimbabwe, (2023). Retrieved from <https://uzt.org.zw/kunda-nqobitb-kn-tb/>

Tuberculosis and Leprosy Management Guidelines: Zimbabwe National TB Control Programme. (2016).

Tuberculosis Research Centre A controlled clinical comparison of 6 and 8 months of anti-tuberculosis chemotherapy in the treatment of patients with silico-tuberculosis in Hong Kong. Hong Kong Chest Service/ Madras/British Medical Research Council. (1991). *The American review of respiratory disease*, 143(2), 262–267. <https://doi.org/10.1164/ajrccm/143.2.262>

Van den Boogaard, J., Lyimo, R., Irongo, C.F., Boeree, M.J., Schaalma, H., Aarnoutse, R.E. and Kibiki, G.S. (2009) Community vs. Facility-Based Directly Observed Treatment for Tuberculosis in Tanzania’s Kilimanjaro Region. *International Journal of Tuberculosis and Lung Disease*, 12, 1524-1529.

WHO 2023, Zimbabwe moves to strengthen collaboration in fight against TB. Retrieved from <https://www.afro.who.int/countries/zimbabwe/news/zimbabwe-moves-strengthen-collaboration-fight-against-tb>

World Health Organization (WHO). Use of high burden country lists for TB by WHO in the post-2015 era.WHO/HTM/TB/2015.29.WHO:Geneva;2015.

https://www.who.int/tb/publications/global_report/high_tb_burden/countrylists-2016-2020.pdf?ua=1. Accessed 19 Oct 2020.

World Health Organization. Global tuberculosis report (2021). Available at: <https://www.who.int/teams/global-tuberculosis-programme/tb-reports/global-tuberculosis-report-2021/>

World Health Organization. Global Tuberculosis Report 2023; WHO: Geneva, Switzerland, 2023 [Google Scholar]

World Health Organization. The End TB Strategy. Geneva: WHO Press; 2015.

Yao, Y., Wei, T., Zhang, H., Xie, Y., Gu, P., Yao, Y., Xiong, X., Peng, Z., Zhen, Z., Liu, S., Cui, X., Mei, L., & Ma, J. (2022). Characteristics of Diagnosed and Death Cases of Pneumoconiosis in Hubei Province, China, 1949-2019. *International journal of environmental research and public health*, 19(23), 15799. <https://doi.org/10.3390/ijerph192315799>

Yarahmadi, A., Zahmatkesh, M. M., Ghaffari, M., Mohammadi, S., Labbafinejad, Y., Seyedmehdi, S. M., Nojomi, M., & Attarchi, M. (2013). Correlation between Silica Exposure and Risk of Tuberculosis in Lorestan Province of Iran. *Tanaffos*, 12(2), 34–40

Zhou, T. J., Lakshminarayanan, S., Sarkar, S., Knudsen, S., Horsburgh, C. R., Muthaiah, M., Kan, C. K., Salgame, P., Ellner, J. J., Roy, G., Jenkins, H. E., & Hochberg, N. S. (2020). Predictors of Loss to Follow-Up among Men with Tuberculosis in Puducherry and Tamil Nadu, India. *The American journal of tropical*

medicine and hygiene, 103(3), 1050–1056. <https://doi.org/10.4269/ajtmh.19-0415>

APPENDIX 1: Interview guide for in-depth interviews

1. Position of Health worker at the Clinic.....
2. Age of health worker
3. The Gender of the health worker.....Male..... Female.....
4. The time the health worker has worked at the clinic.....
5. Trainings on TB and Silicosis during the period under review... (Title of workshops)
6. What is your TB presumptive target per quarter?
7. What is your diagnosis target per quarter?
8. Have these targets been met over the past 3years? A. Yes B. No
9. If not, what are the challenges contributing to you not meeting targets?
10. How often do you conduct TB Review Clinics in a month? A. 1 B. 2 C. 3
11. Have you referred TB patients to Gweru for silicosis screening from your clinic?
A. Yes B. No
12. Have you received feedback from Gweru occupation clinic after referring patients?
A. Yes B. No
13. What is the difference in outcomes for tuberculosis and silico tuberculosis patients?
14. Can you define in general the health seeking behavior of TB and Silicosis Patients?
a. Good b. Better c. Poor d. Very Poor
15. What challenges are you facing in tuberculosis and silicosis programming?
16. Which partners are implementing TB programs in Kwekwe City and what is their contribution?

17. Do you have any recommendations that need to be put in place to improve tb and silicosis programming?

APPENDIX 2: Checklist for records review

1. Number of people screened for tuberculosis and silicosis both at facility and outreach programs from January 2022 to 2024
2. Number of patients diagnosed with tuberculosis, and silico tuberculosis from 2022 to 2024 in the registers
3. Number of TB patients referred to Gweru Occupational Clinic for Silicosis Screening from 2022 to 2024
4. Number of Silicosis patients referred to Kwekwe from Gweru for monitoring and treatment
5. Number of patients initiated on treatment from January 2022 to 2024
6. Number of patients and contacts initiated on TPT from January 2022 to 2024
7. Number of TB and Silicosis and Silico-TB patients admitted at Kwekwe Hospital from 2022 January to 2024
8. Number of patients with proper and complete record
9. Number of patients with evaluated outcomes
10. Comparison of treatment outcomes amongst patients

Appendix 3: Consent Form

My name is Zvichauya Muvango. I am a final year student at Africa University doing Mater of Public Health Program. I am doing a research study entitled The impact of silicosis on Tuberculosis treatment outcomes in Kwekwe City, Midlands Province, Kwekwe January 2022-2024. The study is strictly for academic purposes.

I am kindly asking you to voluntarily participate in my study. Your name or identity will not be disclosed at any point of the study. The data collected will be kept confidential and will not be shared with anyone other than my academic and field supervisor. Your safety and security is assured during the course of the study. You are free to withdraw from the study at any time when you feel like you no longer want to participate.

If you so agree, kindly confirm by signing below

Signature

Appendix 4: Approval Letter for Data Collection

MINISTRY OF HEALTH
KWEKWE GENERAL
HOSPITAL
HUMAN RESOURCES
P. O. BOX 391
KWEKWE



Phone: 055 22333/6 ext. 207
FAX: 055 24089
E-mail : kwekwe.hospital@gmail.com

27 NOVEMBER 2024

ZVICHAUYA MUVANGO
7 TERCOMA CRESCENT
MASASA PARK
KWEKWE

RE: REQUEST TO CARRYOUT AN ACCADEMIC RESEARCH.

The above subject matter refers

Following your request to carry out a research at this organization.

May you kindly note that permission has been granted and the research is strictly for acader learning purposes.

Thank you



Muzira V
For A/Medical Superintendent

Appendix 5: AUREC Approval Letter



AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE (AUREC)

P.O. Box 1320 Mutare, Zimbabwe, Off Nyanga Road, Old Mutare-Tel (+263-20) 60075/60026/61611 Fax: (+263 20) 61785 Website: www.africanu.edu

Ref: AU 3544/25

7 January, 2025

ZVICHAUYA MUVANGO

C/O Africa University
Box 1320
MUTARE

RE: IMPACT OF SILICOSIS ON TUBERCULOSIS TREATMENT OUTCOMES IN KWEKWE CITY, MIDLANDS PROVINCE, ZIMBABWE, 2022 – 2024

Thank you for the above-titled proposal you submitted to the Africa University Research Ethics Committee for review. Please be advised that AUREC has reviewed and approved your application to conduct the above research.

The approval is based on the following.

- a) Research proposal
- **APPROVAL NUMBER** AUREC 3544/25
This number should be used on all correspondences, consent forms, and appropriate document
- **AUREC MEETING DATE** NA
- **APPROVAL DATE** January 7, 2025
- **EXPIRATION DATE** January 7, 2026
- **TYPE OF MEETING:** Expedited
After the expiration date, this research may only continue upon renewal. A progress report on a standard AUREC form should be submitted a month before the expiration date for renewal purposes.
- **SERIOUS ADVERSE EVENTS** All serious problems concerning subject safety must be reported to AUREC within 3 working days on the standard AUREC form.
- **MODIFICATIONS** Prior AUREC approval is required before implementing any changes in the proposal (including changes in the consent documents)
- **TERMINATION OF STUDY** Upon termination of the study a report has to be submitted to AUREC.



Yours Faithfully

MARY CHINZOU
FOR CHAIRPERSON
AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE