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ANALYSIS OF THE BURDEN OF PNEUMOCONIOSIS AMONG MINERS IN MASHONALAND WEST FROM 2017 - 2022

BY

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Abstract

Miners face considerable health risks from pneumoconiosis, a devastating occupational lung illness caused by extended exposure to dust and other working dangers. This study looks at the prevalence, risk factors, and healthcare access of miners in Mashonaland West, Zimbabwe, between 2017 and 2022. Despite the global acknowledgment of pneumoconiosis as a serious occupational health hazard, there is little study on its prevalence in Zimbabwe. The study sought to determine the frequency and incidence of pneumoconiosis among miners, identify associated risk variables, and evaluate healthcare access and utilization over the study period. A cross-sectional study was carried out on a sample of 100 miners chosen by stratified random sampling. Data were gathered using structured interviews and existing health records. Descriptive statistics and multivariate logistic regression analysis were used to investigate the connections between pneumoconiosis and other risk factors, such as workplace dust exposure, personal protective equipment (PPE) use, smoking, and healthcare access. Miners with more than ten years of experience were the most affected, with a 32% prevalence rate, compared to only 10% for those with less than five years of experience.The results suggested that the incidence rate increased by around 5% per year.Artisanal and small-scale miners were found to be the most vulnerable, with more than 30% afflicted with the disease as compared to miners working in large-scale operations had a lower incidence rate of 12%. The highest rates of pneumoconiosis were found among older miners, notably those aged 40 and over. Nearly 29% of this age group were diagnosed with pneumoconiosis, reflecting their long-term exposure to mining dust. Multivariate analysis showed duration of mining experience [AOR = 2.5; 95%CI: 1.8-3.6; p=0.001], Use of PPE [AOR = 0.4; 95%CI: 0.2-0.7; p<0.002, Smoking status [AOR=1.3; 95%CI: 1.1-3.0; p=0.03], Healthcare access frequency [AOR=0.6; 95%CI: 0.3-0.9; p=0.02] to be statistically significant predictors of pneumoconiosis risk.The study emphasizes the critical need for actions to limit dust exposure, enforce workplace safety standards, and improve healthcare access for miners. These findings indicate crucial areas for policy improvement, industry accountability, and community education to reduce the burden of pneumoconiosis on Zimbabwe's miners.

Key words : Pneumoconiosis; Prevalence; Zimbabwe; Miners; Exposure.

Declaration Page

I Yvonne Pasipanodya, do hereby declare that this dissertation 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.

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Dedication

This study is dedicated to my son Nathaniel whose presence in my life is a daily motivation to work hard and become a better version of myself. May he grow up to understand, I did my best.

List of Acronyms and Abbreviations

ASMs	Artisinal Small scale Miners
CWP	Coal Workers Pneumoconiosis
DMO	District Medical Officer
EIA	Environmental Impact Assesment
EMA	Environmental Management Agency
NSSA	National Social Security Authority
OHS	Occupational Health and Safety
PMD	Provincial Medical Director
PPE/C	Personal Protective Equipment/Clothing
WHO	World Health Organization
ZMF	Zimbabwe Miners Confederation

Definition of Key Terms

Artisinal Small scale Miners	refers to mining by individuals, groups, families or cooperatives with minimal or no mechanisation who are not government registered.
Base minerals	means all minerals and mineral substances such as precious metals, precious stones, and includes all such slimes, concentrates, slags, tailings and residues as are valuable and contain base minerals.
Mine	includes any placeexcavation whereby any operation in connection with mining purposes is carried on.
Miner	means a person 18 years or older carrying on the work of mining on any mining location.
Mineral	means any substance occurring naturally in or on the earth, which has been formed by or subjected to a geological process.
Pneumoconiosis	means any disease of the respiratory organs due to the inhalation of mineral dust.
Worker	means any person who performs work or services for another person for remuneration or reward.

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CHAPTER 1 INTRODUCTION

1. Introduction

1.1 Overview of the study

The prevalence of pneumoconiosis among miners in Mashonaland West, Zimbabwe, from 2017 to 2022 was included in this study. The mining industry in Zimbabwe has lost a significant amount of labor . The researcher went over the preliminary literature review and its factors under literature review. The researcher went over the research design, study setting, data collection method, data analysis, validity and reliability, as well as ethical aspects and analysis of the final results obtained from the field. These sub-topics were used to introduce the burden of pneumoconiosis among miners in Mashonaland West Zimbabwe from 2017 to 2022.

1.2 Background of the Study

Zimbabwe's economy has historically been based on mining, especially in the Mashonaland West area, which is renowned for its abundant mineral reserves, including gold, platinum, and asbestos. While the mining industry has significantly boosted economic development and employment opportunities, it has also significantly increased the health risks for workers, particularly in the form of pneumoconiosis, a group of chronic and crippling lung diseases brought on by the inhalation of dust particles that frequently contain hazardous substances (Moyo et al., 2021).

According to Hall et al. (2021), pneumoconiosis, which includes illnesses including silicosis, asbestosis, and coal workers' pneumoconiosis, has been acknowledged as an ongoing and preventable occupational health threat in mining communities around the world. Particularly vulnerable are workers who are exposed to coal dust, asbestos, and respirable crystalline silica. These dust particles can build up in the lungs after being inhaled for an extended length of time, which can cause irreparable lung damage, decreased lung function, and a variety of respiratory symptoms. According to Onder, Elice, and Sogut (2020), a number of variables, such as the kind of mineral dust exposure, duration of exposure, and the efficacy of dust management methods, affect the severity and prevalence of pneumoconiosis. There haven't been many thorough studies looking at the prevalence, causation, and effects of these disorders among miners worldwide, despite the known dangers of mining-related pneumoconiosis. Given the region's long history of mining operations and the possible health effects on miners and their families, this information gap is alarming.

Pneumoconiosis in surface coal miners in the United States was evaluated by Hall, Halldin, Blackley, and Laney (2020) following the creation of a national radiography surveillance program. Findings show that 109 (1.6%) surface coal miners had pneumoconiosis, including 12 with progressive massive fibrosis, the most severe form of the condition. After accounting for duration of surface mining, it was discovered that surface miners in Central Appalachia and those who worked as drillers or blasters had a higher chance of developing pneumoconiosis. The study came to the further conclusion that pneumoconiosis among surface coal miners warrants their inclusion in an organized program for monitoring their respiratory health. The results of the current surveillance are in line with earlier findings of pneumoconiosis, notably silicosis, in jobs related to surface mining like drilling and blasting.

In Australia, Lu, Dasgupta, Cameron, Fritschi, and Baade (2021) reported the results of their study on the prevalence, mortality, and survival of coal mine dust lung illness from international studies. Modern coal miners continue to have occupational lung ailments, which emphasizes the significance of respiratory surveillance and preventive efforts through efficient dust control techniques. Understanding the current disease burden in other nations that produce coal is hampered by the lack of prevalence studies from nations other than the United States.

Research on the analysis of Pneumoconiosis Cases and Characteristics from 2004–2019 in Shandong Province was completed in China by Chen, An, Ma, and Fu in 2023. They noted in their conclusion that Shandong Province still had a significant pneumoconiosis morbidity rate. Modern coal miners continue to have occupational lung ailments, which emphasizes the significance of respiratory surveillance and preventive efforts through efficient dust control techniques. Understanding the current disease burden in other nations that produce coal is hampered by the lack of prevalence studies from nations other than the United States.

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Investigating the pneumoconiotic potency of coals, Kamanzi, Becker, Jacobs, et al. (2023) describe their research on the influence of coal mine dust properties on pathways to respiratory damage. The physicochemical properties of coal mine dust, such as mineralogy/mineral chemistry, particle shape, size, specific surface area, and free surface area, were given particular attention in their review of studies because they have all been identified as contributing factors to the expression of pro-inflammatory responses in the lung. The review also points out a potential need for more comprehensive risk characterisation methodologies for coal mine dust, which take into account the physicochemical and mineralogical characteristics of the dust as variables pertinent to the currently hypothesized processes for CWP pathogenesis.

Among their study titled "Tuberculosis and Silicosis Burden in Artisanal and Small-Scale Gold Miners in a Large Occupational Health Outreach Programme in Zimbabwe," Moyo, Zishiri, Ncube, et al. (2021) reported their findings in Zimbabwe. The prevalence of tuberculosis, silicosis, and silico-TB among ASMs (Artisanal and small-scale miners) in Zimbabwe was quite high, despite the fact that their cross-sectional findings were just preliminary. ASMs in Zimbabwe required access to a full range of occupational health services, including TB and silicosis surveillance. Interventions were required to lessen exposure to silica-containing dust by promoting safer mining practices. The Zimbabwe Miners Federation, Ministry of Mines, Ministry of Labor and Social Services, and Ministry of Health and Child Care must work together more closely as a result.

The period from 2017 to 2022 is critical for determining the extent of pneumoconiosis in this area. According to Moyo et al. (2021), there were modifications to mining procedures, rules, or exposure levels during this time that might have had a major effect on the health of miners. It is critical to comprehend the state of pneumoconiosis among miners for a number of reasons:

Given these factors, the objective of this study is to close the information gap by undertaking a thorough review of the prevalence of pneumoconiosis among miners in Mashonaland West, Zimbabwe, between 2017 and 2022. By examining the prevalence, causes, and impact of these diseases, this research seeks to contribute to the betterment of occupational health and safety practices, the enhancement of miners' quality of life, and the overall well-being of the mining communities in the region.

1.3 Statement of the Problem

In Mashonaland West, Zimbabwe, pneumoconiosis, a series of occupational lung disorders brought on by dust exposure, continues to be a major public health concern, Vlahovich and Sood (2019). Despite numerous safety rules and precautions, mining has a long history in the area, and miners are still often exposed to dangerous levels of respirable dust. An increase in curiosity on the prevalence of pneumoconiosis in this particular region has been observed between 2017 and 2022.

According to the survey, the province has a high prevalence of this illnesses. During the designated time, pneumoconiosis cases among miners in Mashonaland West persisted at alarming rates despite attempts to decrease exposure and enhance workplace safety. This research project will reveal the prevalence rate because it is still unclear how common and widespread the sickness is in this area. Inadequate reporting and surveillance mechanisms are a current issue. Pneumoconiosis cases among miners in the area are not routinely monitored or reported. The creation of successful prevention and intervention methods is hampered by the absence of adequate data.

The province's major problem is that miners have little access to healthcare. For miners with pneumoconiosis, access to healthcare facilities and specialized medical services is frequently insufficient. In addition to making the misery of those who are afflicted worse, this prevents the disease from being detected and treated early on. In addition to the aforementioned difficulties, injured miners must deal with several economic and social repercussions. In addition to having a negative impact on the health and wellbeing of miners, pneumoconiosis also has substantial economic and social repercussions. The condition may cause miners to lose their jobs, earn less money, and have trouble supporting their families.

The allocation of funds for programs in Mashonaland West that prevent and control pneumoconiosis is impacted by the disease's perceived burden, which leads to inadequate resource management. For well-informed decision-making, accurate data on disease prevalence and associated costs are essential. A thorough examination of the prevalence of pneumoconiosis among miners in Mashonaland West, with a focus on the years 2017 to 2022, is urgently needed in light of these difficulties. Such a study can help to shed light on the scope of the issue, pinpoint high-risk populations, and guide the development of evidence-based policies and interventions aimed at lowering the prevalence and effects of pneumoconiosis in the area.

1.4 Main aim of the Study

To analyse the burden of pneumoconiosis among miners in Mashonaland West Zimbabwe and the associated factors in selected health facilities, 2017 to 2022.

1.4.1 Specific Objectives of the Study

I. To Estimate the Prevalence and Incidence of Pneumoconiosis Among Miners in Mashonaland West (in selected health facilities), Zimbabwe from 2017 to 2022.

II. To Identify Risk Factors Associated with Pneumoconiosis among miners in Mashonaland West (in selected health facilities), Zimbabwe, period 2017 to 2022.

III. To Assess Healthcare Access and Utilization among miners in Mashonaland West (in selected health facilities), Zimbabwe from 2017 to 2022.

1.5 Research Questions

i. What were the prevalence and incidence rates of pneumoconiosis among miners in Mashonaland West during this period?

ii. What types of mining activities were associated with a higher risk of pneumoconiosis?

iii. Did miners have adequate access to healthcare services for diagnosis and treatment of pneumoconiosis?

1.6 Justification of the Study

There are various significant justifications for examining the prevalence of pneumoconiosis among miners in Mashonaland West, Zimbabwe, from 2017 to 2022. This study's first focus is on occupational health issues. Pneumoconiosis is a devastating occupational lung illness that mostly affects those who work in mines. It includes disorders like coal worker's pneumoconiosis (CWP) and silicosis. With the right safety precautions and rules, these diseases can be completely avoided. To safeguard the security and wellbeing of Zimbabwean miners, it is crucial to determine the scope of the issue.

Since the health of miners has consequences for wider public health, this research will also have an impact on it. In addition to harming those who are exposed to risky mining circumstances, pneumoconiosis can spread illnesses like tuberculosis within mining communities. Therefore, for public health planning and intervention efforts, quantifying the burden of pneumoconiosis is essential.

Since miners have a legal right to a safe and healthy workplace, this research will also be important for worker safety and rights. Understanding the prevalence of pneumoconiosis can help determine if mining corporations and regulatory agencies are doing enough to safeguard the rights and safety of miners. By using this analysis, policymakers in Zimbabwe may be able to adjust their policies as needed and enforce safety regulations. Evidence-based policies will benefit from reliable data on pneumoconiosis. The research will help shape laws and policies that protect miners' health and safety by limiting their exposure to dust.

Additionally, this article will assist the government and other contributors in allocating resources. Prioritizing health issues based on their prevalence and impact will be essential because health resources are frequently scarce. This study will help with more efficient resource allocation by focusing on areas with a higher burden of pneumoconiosis. Additionally, since mining is a key economic activity in Zimbabwe, particularly in Mashonaland West, this research will have a higher economic impact. Pneumoconiosis is one health condition that affects miners, and it can have an economic impact owing to lost production and increased healthcare expenditures. The Zimbabwean government will be able to calculate these economic effects with the aid of a burden analysis.

The prevalence and trends of pneumoconiosis can be followed over time to evaluate the efficacy of interventions and preventive measures that were put in place throughout the study period. This study will aid in determining whether initiatives to lessen the disease's burden have been successful. Furthermore, a thorough evaluation of the pneumoconiosis burden can guide the selection of research areas and financial support. It can help researchers and politicians focus their efforts on areas with the greatest needs, like enhancing mining safety procedures and creating more effective therapies for those who are harmed. Finally, this study will contribute to greater awareness. Data on the prevalence of pneumoconiosis will be an effective instrument for advocating for change and spreading awareness of the health risks faced by miners. It will result in more people being in favor of giving Zimbabwean miners access to healthcare services and improved working conditions.

In conclusion, analyzing the burden of pneumoconiosis among miners in Mashonaland West, Zimbabwe, from 2017 to 2021 is justified due to its significant public health, economic, and social implications. This analysis can provide valuable insights for improving occupational safety, protecting worker rights, and enhancing the overall well-being of miners in the region.

1.7 Delimitations of the Study

Pneumoconiosis prevalence among miners in Mashonaland West, Zimbabwe, is evaluated in the study from 2017 to 2022. Mashonaland West was selected because the researcher resides in the region being studied and can conduct the research there conveniently. Additionally, the prevalence of pneumoconiosis among miners was a factor in the decision. Because it will be easy to obtain, this study will employ secondary data gathered from medical health facilities in the province.

1.8 Limitations of the Study

To give readers a thorough picture of the breadth and potential limitations of the research findings, the study's limitations will be stated. The study's potential shortcomings are listed below. It looked at the prevalence of pneumoconiosis among miners.

First, data quality and availability may not be ensured. The thoroughness and correctness of the study will be impacted by the limited availability and quality of secondary data. Pneumoconiosis cases may be under-reported or incorrectly classified as a result of incomplete or inconsistent data. The researcher will ask for data from accountable departments and carry out some quality assessment to solve this constraint.

Another constraint that the researcher has taken into account is data bias. The study relies on current data sources, which can be biased in reporting or selection. The data won't include miners with less severe symptoms or those who choose not to seek medical attention. This constraint was addressed by the researcher by gathering and comparing data from various medical institutions and sources (provincial hospital, ministry of health and child care, etc.).

Additionally, it has been emphasized that this research has limitations due to data missingness, which will influence the results. The study will be impacted by missing data, notably in medical records or questionnaires. The degree and distribution of missing data will be taken into account and properly resolved. Thorough data cleansing will be used to overcome this constraint.

Data privacy and ethics were also mentioned by the researcher as potential limitations of this study. Strict ethical and privacy standards must be followed while using medical records and other personal information. Limiting data access and introducing logistical difficulties are two effects of ensuring data security and privacy protection. The relevant authorities will provide author permission to examine their databases in order to remedy this.

The absence of resources has also been mentioned as a study limitation. The scope and complexity of the investigation, including the ability to conduct in-depth fieldwork or diagnostic confirmation, will be impacted by resource limits like funding, manpower, and time constraints. The researcher will create her own budget to account for logistical and temporal restrictions in order to solve this constraint

CHAPTER 2 REVIEW OF RELATED LITERATURE

2.1 Introduction

Pneumoconiosis continues to be a major occupational health hazard in mining industries around the world. Despite improvements in health and safety standards, the disease still affects miners in both industrialized and poor countries. The study conducted in 2020 found that the majority of new cases of pneumoconiosis in China are related to coal mining, where workers are exposed to high levels of respirable dust due to inadequate enforcement of safety regulations in some regions. Despite the implementation of dust control measures, pneumoconiosis remains a leading occupational disease in the country. China is one of the largest mining countries (Zhao, Z. et al. (2020).

Despite regulatory efforts by the Mine Safety and Health Administration (MSHA), pneumoconiosis among coal workers in the United States has resurfaced, particularly in Appalachia. According to a 2020 study, CWP, also known as "black lung disease," has been increasing during the 2000s after dropping for decades. This revival has been related to inhaling coal dust with a higher silica content. Furthermore, studies show that younger miners are increasingly being diagnosed with severe types of pneumoconiosis, most likely as a result of extended exposure to finer dust particles (Liu, Q. et al. (2021). South Africa, a country with a long history of gold and diamond mining, is still combating silicosis among its miners.

The prevalence of silicosis remains high due to long-term exposure to silica dust in gold mining. A 2019 study highlighted the difficulty of limiting dust exposure in older mines, which frequently lack the most recent dust control equipment. Furthermore, there is continuous litigation concerning miners suffering from silicosis, with major settlements aimed at compensating workers and their families(Walker, N.

et al. 2019). In developing countries such as India and Zimbabwe, pneumoconiosis is a serious but underreported health problem. In India, coal miners and stone crushing and quarrying workers are exposed to high levels of respirable crystalline silica (RCS), which contributes to an increase in silicosis incidence. According to studies conducted between 2019 and 2022, dust control standards are not strictly enforced, and access to healthcare services in mining areas is limited. Similarly, in Zimbabwe, miners continue to be affected by silicosis and other dust-related ailments, while data is generally scarce due to a lack of adequate health monitoring systems.

2.2 Zimbabwean Context

In Zimbabwe, mining is a significant economic activity, contributing to employment and foreign exchange earnings. However, the occupational health risks associated with mining, particularly dust-related diseases such as pneumoconiosis, remain a critical concern. Pneumoconiosis, including silicosis and coal workers' pneumoconiosis (CWP), is caused by the inhalation of dust particles, especially silica, prevalent in mining environments. Existing studies and health data on pneumoconiosis in Zimbabwe are limited since the country has not routinely monitored occupational diseases on a national scale. However, regional health surveys and localized research in mining towns shed light on the prevalence of dust-related disease.

Mutetwa et al. (2020) found that many workers, particularly in small-scale and artisanal mining, were unaware of the hazards connected with dust exposure. This ignorance, along with a lack of protective equipment, resulted in excessive amounts of dust inhalation. The study stressed the importance of enhanced occupational health education and the implementation of dust control rules in Zimbabwe's mining sector. Makotore et al. (2021) investigated the prevalence of pneumoconiosis in gold mining operations in the Midlands Province of Zimbabwe and found that approximately 15% of miners showed early signs of silicosis. Despite this, most miners were not receiving regular health screenings. The authors pointed out the lack of enforcement of Zimbabwe's Mining dust Regulations, which require mines to reduce dust exposure through ventilation and other means . Health studies from organizations such as the National Social Security Authority (NSSA) have emphasized the difficulties in addressing occupational diseases such as pneumoconiosis. According to the NSSA's 2021 report, there has been an increase in incidence of respiratory disease among miners, while specific data on pneumoconiosis is limited due to underreporting and inadequate diagnostic facilities. NSSA also highlighted the scarcity of specialized respiratory healthcare facilities, particularly in rural mining areas like Mashonaland West.

2.3 Conditions in Mashonaland West that Exacerbate Dust-Related Diseases

Mashonaland West is a prominent mining region in Zimbabwe, producing substantial amounts of gold, limestone, and other minerals. Several elements peculiar to this location may aggravate dust-related disease such as pneumoconiosis. Many mining operations in Mashonaland West are artisanal and informal, with miners frequently lacking access to protective equipment and effective dust control techniques. According to Chikowore et al. (2019), artisanal miners are exposed to high quantities of silica dust because of the laborious procedures used to extract gold and other minerals. This exposure raises the risk of silicosis, particularly in poorly ventilated areas.Mashonaland West's geological makeup, notably in locations like Kadoma and Chinhoyi, contains large quantities of silica in rock formations.

The mining of silica-containing materials, combined with dry circumstances, produces high volumes of airborne dust. These factors promote the intake of respirable crystalline silica (RCS), one of the leading causes of silicosis. While Zimbabwe's legal framework for occupational health and safety exists, enforcement is frequently lax, particularly in isolated areas. Inspections by the Ministry of Mines and Mining Development are sporadic, and many miners in Mashonaland West operate without regular supervision. This absence of control permits hazardous working conditions, such as prolonged dust exposure, to continue.Mining settlements in Mashonaland West frequently have poor access to healthcare services, especially specialized respiratory care. According to a paper by Moyo and Sibanda (2020), many miners do not receive routine health exams since there are no close health facilities capable of identifying occupational lung disease. This delays the diagnosis and treatment of pneumoconiosis.

2.4 Recommendations for Addressing Pneumoconiosis

Given the conditions in Mashonaland West, it is critical to improve both preventative measures and healthcare services in order to reduce the prevalence of pneumoconiosis. Mining operations, particularly small-scale and artisanal activities, must implement better dust control methods, such as wet drilling and enhanced ventilation systems. Mining businesses should also provide miners with appropriate personal protective equipment (PPE), such as respirators. Mine workers should be required to get regular health exams, including chest X-rays, in order to detect early signs of pneumoconiosis. Strengthening health surveillance systems will aid in the detection of occupational lung illnesses. Zimbabwe's current occupational health laws should be strengthened, with more frequent inspections of mining enterprises in areas such as Mashonaland West. Penalties for noncompliance should be raised to ensure that mining corporations follow safety regulations.

2.5 Occupational Health Regulations in Zimbabwe: Mining Sector

Zimbabwe's mining industry is governed by a system of occupational health and safety (OHS) laws designed to safeguard workers from the risks connected with mining activities. However, these regulations are difficult to implement and enforce. To determine their effectiveness, the key legislative frameworks of Zimbabwe must be examined and compared to worldwide best practices. The Mines and Minerals Act (Chapter 21:05) is the primary legal framework for occupational health and safety in Zimbabwe's mining sector, and it is enforced by the Ministry of Mines and Mining Development. The Factories and Works (Mining) Regulations add to this act by addressing dust management, ventilation, and mining safety.

The Factories and Works Act mandates mining companies to manage dust levels through sufficient ventilation, particularly in deep mines. Section 201 of the Factories and Works (Mining) Regulations requires regular monitoring of dust levels and the implementation of necessary measures to reduce exposure to hazardous chemicals such as silica. The regulations require miners to undergo periodic health surveillance, which includes medical examinations to detect occupational diseases such as pneumoconiosis. However, in fact, these exams are rarely completed consistently, especially in small-scale and artisanal mining operations.The regulations require that miners be given with personal protection equipment (PPE), such as respirators and protective clothing, particularly in high-risk situations with dust and hazardous substances.

Despite the presence of these restrictions, their implementation has been restricted, with many miners working in hazardous conditions, notably in the informal mining sector. Chikova et al. (2019) noted the variability in enforcement, stating that many mining businesses, particularly small-scale operators, fail to comply with regulations due to a lack of inspections and lax fines for noncompliance.

Countries with advanced mining sectors, such as Australia, the United States, and South Africa, have developed strong OHS frameworks that serve as benchmarks for best practices in the industry.United States: Mining Safety and Health Administration (MSHA) The Mine Safety and Health Administration (MSHA) regulates the US mining industry and implements the Federal Mine Safety and Health Act of 1977. MSHA requires constant monitoring of dust exposure, with rigorous limitations on respirable coal dust and silica levels.

In addition, miners must employ dust suppression technology such as water sprays and air filtration systems to reduce dust dangers.Miners must undergo mandatory health examinations, including chest X-rays, to detect early signs of pneumoconiosis. Health surveillance is required at regular periods throughout a miner's career to detect diseases early on.MSHA conducts regular and unannounced inspections of mining operations, with severe consequences for noncompliance, including fines and mine closures. This thorough enforcement assures high compliance with the safety rules. Australia: Safe Work Australian and Queensland Mining Regulations In Australia, occupational health in the mining industry is governed by Safe Work Australia, with state-specific rules such as Queensland's Coal Mining Safety and Health Act 1999 providing extra guidance.In Queensland, mining companies are obligated to conduct mandatory medical tests on miners exposed to dust, with monthly follow-ups.

The resurgence of coal workers' pneumoconiosis in recent years prompted regulations requiring more frequent health checks and improved diagnostic criteria.Australia has embraced modern dust suppression technologies, such as misting systems and sealed ventilation in underground mining operations. These advances have greatly lowered dust levels and helped miners avoid exposure to respirable crystalline silica (RCS).

2.6 Comparison of Zimbabwean Regulations with International Best Practices

While Zimbabwe has a framework in place to govern health and safety in the mining industry, there are some areas where it falls short of international norms.Unlike the United States and Australia, where regulatory organizations such as MSHA undertake frequent and unannounced inspections, Zimbabwe's enforcement is lax due to limited resources. The Ministry of Mines lacks the capacity to perform regular inspections, therefore small-scale operations frequently go unnoticed, resulting in noncompliance with dust control measures and other safety laws. Miners in Australia and the United States must undergo regular health examinations.

While health surveillance is legally required in Zimbabwe, it is not always carried out, particularly in rural areas. More systematic health monitoring systems and regular medical tests are required to detect early symptoms of pneumoconiosis and other occupational disease.Advanced mining sectors use sophisticated dust suppression devices, which are largely absent from Zimbabwe's small and medium-sized mines. Modern technology such as misting and air filtration systems could help to limit dust exposure in Zimbabwean mines.

To integrate Zimbabwe's occupational health and safety standards with international best practices Zimbabwe should enhance the frequency of mine inspections, particularly in small-scale and artisanal mining operations, and apply harsher fines for noncompliance with dust control measures and other safety standards.The government should implement a comprehensive health surveillance system that requires miners to undergo frequent screenings, with a focus on early detection of occupational ailments like pneumoconiosis. Zimbabwean mines should implement modern dust management technologies and best practices from nations like Australia and the United States, such as wet drilling, water sprays, and enclosed ventilation systems.Creating open avenues for workers to report dangerous circumstances without fear of retaliation can assist improve overall safety and health results in Zimbabwe's mining industry.

2.7 Theoretical Framework: The Epidemiological Model of Disease Causation

Pneumoconiosis, a set of lung disease caused by inhaling dust, notably respirable crystalline silica (RCS) and coal dust, poses a substantial occupational health risk in mining. The disease is a significant challenge in Mashonaland West, Zimbabwe, where mining is an important element of the local economy, due to prolonged and high dust exposure in poorly controlled mining operations. To better understand the complex interplay of factors that lead to the start of pneumoconiosis, this study employs the Epidemiological Model of Disease Causation, which looks at the interaction of three elements: the host (miner), the agent (dust), and the environment (working conditions).

The host in this framework refers to the miners, who are the individuals exposed to dangerous dust in their working environment. Several reasons make miners vulnerable to pneumoconiosis. The duration of dust exposure is one of the most important elements to consider. Many Zimbabweans work in mining for a long time, and extended exposure to dust in these situations raises the risk of lung disease. Furthermore, the miners' age and health status significantly influence their vulnerability to pneumoconiosis. Older miners, who have been mining for more years, are at a higher risk because to their prolonged exposure. Similarly, miners with pre-existing respiratory diseases or compromised immune systems are more susceptible to the negative consequences of dust exposure. Genetic predispositions to lung issues can make some people more likely to develop pneumoconiosis.

These variables increase the chance of contracting the disease, particularly among miners operating in unsafe conditions in Zimbabwe's small-scale and artisanal mining operations. The agent in this model is the dangerous dust that miners inhale while working. In mining activities, the two main forms of dust that cause pneumoconiosis are respirable crystalline silica (RCS) and coal dust. The concentration and type of dust to which miners are exposed affect the severity of their health consequences. Higher quantities of silica dust, for example, raise the risk of silicosis, a type of pneumoconiosis. The size of the dust particles also matters, with smaller particles (less than 10 microns) being more hazardous since they can penetrate deeply into the lungs, causing scarring and inflammation.

The third component of the model, the environment, relates to employment settings that either reduce or increase exposure to hazardous dust. The mining environment in Zimbabwe, notably in Mashonaland West, is frequently characterised by poor ventilation, insufficient dust control measures, and risky working practices. Many mining operations lack or employ insufficient dust suppression technology, which are critical for decreasing miners' exposure to hazardous particles. Advanced technologies such as misting systems and air filtration units aid in dust control in large-scale mining operations, but such measures are uncommon in small-scale or artisanal mining operations. Furthermore, miners are frequently issued with insufficient or improper personal protective equipment (PPE), such as respirators, which are critical for preventing workers from inhaling hazardous dust. Even when

PPE is given, miners may not be properly trained or may fail to utilize it on a consistent basis owing to discomfort or a lack of supervision. This contributes to high levels of dust inhalation, which can lead to pneumoconiosis. Another important part of the environment is the regulation and implementation of occupational health and safety regulations.

In Zimbabwe, the mining industry is governed by the Mines and Minerals Act and the Factories and Works Act, which require dust control and worker protection. However, implementation of these standards is frequently lacking due to resource restrictions, particularly in small-scale and artisanal mining activities. Regulatory organizations, such as the National Social Security Authority (NSSA), lack the resources to perform regular inspections, and the penalties for noncompliance are insufficient to encourage businesses to follow the rules.

The Epidemiological Model of disease Causation stresses how these three elements—host, agent, and environment—interact to determine illness risk. Miners, the hosts, are exposed to hazardous dust (the agent) in the workplace, which might raise or decrease the risk of inhalation. In Mashonaland West, the combination of these factors is very difficult. Miners, particularly those in artisanal mining, are exposed to high levels of dust due to inadequate dust control methods, and weak regulatory enforcement permits these hazardous conditions to persist. Furthermore, miners' personal characteristics, such as extended hours of exposure and limited health surveillance, make them particularly vulnerable to pneumoconiosis.

This framework offers a complete lens through which to examine the prevalence of pneumoconiosis in Zimbabwean miners. Examining how these three variables interact reveals that treating the disease requires a multifaceted strategy. Improving the implementation of health and safety standards, equipping miners with improved PPE, deploying contemporary dust control technology, and ensuring miners receive regular health surveillance can all help to minimize the prevalence of pneumoconiosis. Finally, the success of these measures is dependent on enhancing Zimbabwe's regulatory system and ensuring that miners, particularly those in small-scale enterprises, have access to safer working conditions.

2.8 Type of mining and dust exposure

The risk of pneumoconiosis can be considerably influenced by the type of mining, including coal mining, silica mining, and other types of mining. Some mining processes expose workers to more dust than others. Leung, Yu, and Chen (2021) claim that due to differences in dust composition and exposure levels, the kind of mining (such as coal, silica, or gold) has a substantial impact on the risk of pneumoconiosis. The extent and length of miners' exposure to hazardous particles and respirable dust are key factors in influencing the rates of (Moyo et al., 2021). Long-term exposure to high levels of dust puts miners at increased danger.

2.9 Occupational Safety Measures

Effective workplace safety measures can lower the risk of pneumoconiosis and affect prevalence and incidence rates. Examples of such measures are dust management, adequate ventilation, and personal protective equipment. Effective worksite safety measures, such as dust management, suitable ventilation, and the use of personal protective equipment, can lessen dust exposure and minimize the prevalence of pneumoconiosis (Mandal, 2020; Azman et al., 2021).

2.10 Regulatory and Policy Framework

By assuring adherence to safety precautions, the presence and implementation of safety rules and procedures in the mining industry play a key role in lowering pneumoconiosis rates. According to Mandal (2020), economic factors might affect the prevalence and incidence of pneumoconiosis, including employment conditions and laws governing miners' rights and benefits.

2.11 Healthcare Access

Both the frequency and incidence rates can be influenced by the accessibility of healthcare facilities and early detection. Bhagia et al. (2020) claim that through assuring adherence to safety precautions, the presence and enforcement of safety rules and policies in the mining industry play a vital role in lowering pneumoconiosis rates. Early pneumoconiosis case detection may result from improved access. According to Neupane and Karki (2019), informing miners about the dangers of pneumoconiosis and possible preventive actions can help to lower disease rates.

It's crucial to remember that pneumoconiosis is a condition that may be avoided, and actions to lessen exposure to respirable dust and enhance safety protocols can significantly lower its prevalence and incidence rates among miners. For the purpose of evaluating the efficacy of preventative measures and directing public health initiatives in mining communities, regular monitoring and reporting of these rates is crucial.

2.12 Mining activities associated with a higher risk of pneumoconiosis

A higher risk of pneumoconiosis is linked to specific mining operations and industries because of increased exposure to hazardous materials and respirable dust. The risk varies based on the type of mining, the working environment, and whether or not there are efficient dust management systems in place. According to Wang et al. (2023), the following mining activities and industries may increase the risk of pneumoconiosis:

Mining of Silica: Miners working in the mining of silica, notably in the sandstone, granite, or quartzite industries, have a higher risk of developing silicosis due to exposure to the very dangerous crystalline silica dust.

Gold Mining: The risk of silicosis and pneumoconiosis increases when gold miners, particularly those who work in underground mines, are exposed to dust that contains silica, quartz, and other dangerous minerals.

Hardrock mining: Activities involving hardrock mining, such as the extraction of metals like copper, lead, and zinc, may produce respirable dust and expose employees to different types of mineral dust that represent a risk of pneumoconiosis.

Drilling and Tunneling: Miners working in drilling and tunneling projects, such as building roads or tunnels, may be exposed to high levels of dust, which increases their chance of developing pneumoconiosis.

Quarrying: Quarry workers are more likely to acquire pneumoconiosis if dust control measures are weak because they are exposed to dust from different rocks and minerals.

Construction and Demolition: Workers in these fields who perform tasks like drilling, cutting, or abrasive blasting may be exposed to respirable dust, especially silica, which raises their chance of developing pneumoconiosis.

2.13 What interventions, such as respiratory protection or health education, were implemented to reduce the risk of pneumoconiosis?

In order to lower the risk of pneumoconiosis among employees in high-risk industries, numerous interventions have been put in place. The objectives of these interventions are to reduce worker exposure to respirable dust, to advance worker health and safety, and to increase understanding of the dangers of pneumoconiosis. The following are important interventions:

Respiratory Protection: Pneumoconiosis risk is lower when personal protective equipment (PPE) is used. supplying miners with the proper respiratory protective gear, such as powered air-purifying respirators (PAPRs) or N95 masks, to lessen dust inhalation (Onder, Elice and Sogut, 2020). Another strategy employed by mining owners to lower the danger of pneumoconiosis is fit testing and training. In order to maximize the effectiveness of respiratory protection, Wang et al. (2023) recommend that thorough fit testing and instruction be provided on how to utilize it properly. Protecting your lungs from hazardous dust particles, such as silica, which can cause pneumoconiosis, can assist. According to Azman et al. (2021), health education and training programs help workers become more aware of the hazards of pneumoconiosis and give them the tools they need to take preventative action to safeguard themselves.

Engineering Controls: It is necessary to implement dust control measures in order to lower the risk of pneumoconiosis. Rajasekaran, Schweitzer, and Khan (2018) recommended using engineering controls, such as dust suppression systems, water spraying, and ventilation systems, to lower dust levels in mining and construction areas. Pneumoconiosis risk can be decreased by employing physical enclosures and barriers to collect dust generated during operations in addition to the previously described dust management strategies. Additionally, as recommended by Cullen and Hnizdo (2019), using dust extraction devices on machinery and equipment to catch and remove dust at the source is also useful.

Administrative Controls: Other methods for lowering the risk of pneumoconiosis include scheduling work, enforcing workplace rules, and investing in training and education. enforcing and upholding occupational health and safety laws that call for routine monitoring and set acceptable exposure limits (PELs) for dust. Rajasekaran, Schweitzer, and Khan (2018) attest to the value of implementing work schedules that reduce exposure to dust, including rotating people out of high-exposure areas. According to Hall et al. (2020), the risk of pneumoconiosis can be decreased by offering workers training and educational programs on dust dangers, safe work practices, and the appropriate use of PPE.

Occupational Health Services and Surveillance: Health treatments that lower the risk of pneumoconiosis include case management, regular health exams, and early detection. ensuring that miners have access to high-quality healthcare services, including diagnostic tests and lung disease treatment. According to Cullen and Hnizdo (2019), managing diagnosed instances of pneumoconiosis with appropriate medical care, counseling, and support services is also crucial for lowering the risk of pneumoconiosis among miners. conducting routine health examinations, such as lung function testing and chest X-rays, for employees who are at risk for pneumoconiosis. early detection of pneumoconiosis cases to enable prompt medical intervention (Onder, Elice and Sogut, 2020).

Community Engagement and International Collaboration: Pneumoconiosis risk can be decreased through interacting with mining communities and regional stakeholders to increase awareness, receive feedback, and address issues linked to the disease. To lower the danger of pneumoconiosis, mining professionals must also exchange best practices. Collaboration at the international level to share best practices and lessons learned in pneumoconiosis prevention, as indicated by Bhagia et al. (2020).

To establish comprehensive pneumoconiosis prevention programs, these therapies are frequently used in conjunction with one another. Their success depends on the determination of employers, governments, oversight organizations, and employees to give occupational health and safety first priority and lower the risk of pneumoconiosis in high-risk industries.

CHAPTER 3 METHODOLOGY

3.1 Introduction

In order to assess the prevalence of pneumoconiosis among miners, secondary data was gathered and examined from a variety of sources. The burden of pneumoconiosis among miners can be better understood using secondary data with support of oher primary data collection tools. But throughout the study, guarantee was given to data veracity, quality, and ethical issues. Collaboration with pertinent stakeholders and subject-matter experts also improved the study's quality and effectiveness.

3.2 General Setting

Mashonaland West is a province of Zimbabwe with an area of 57 441 square kms and it is the second largest province in Zimbabwe and has a population of 1.5 million (2012). Chinhoyi is the capital of the province and other urban centres are Kadoma, Chegutu, Norton, Karoi, Kariba, Banket and Chirundu. The Province has seven administrative districts and these are; Kariba, Sanyati, Zvimba, Chegutu, Makonde, Mhondoro Ngezi and Hurungwe. The Province lies in the north of the nation and shares a northern border with Zambia on the international level. The province shares internal borders with Harare and Mashonaland East in the south east, Matebeleland North in the west, Midlands Province in the east, and Mashonaland Central in the east. Mining activities are carried out by both sexes but mostly men in the province. As a result, anyone involved in the extraction and/or processing of minerals from the ground was considered a miner. This province has most parts of the great dyke which is rich in mineral resources and has more miners along the area. All willing miners are welcome to use medical health facilities in the province, which was set up at the artisanal and small-scale gold mining locations.

3.3 Study Design

To analyze this research study, the researcher made use of secondary data and primary data collection tools usage. A study technique known as secondary research made use of data that had already been collected. To improve the overall effectiveness of the research, existing data was compiled and summarized (Moyo et al., 2021). A widely used research technique was to use secondary research. It was frequently used in research designs or as a technique to begin the research process if primary research was intended to be conducted later. Occupational health records of miners who were screened for TB and silicosis at the selected health facilities in Mashonaland West Zimbabwe and those consulted during a medical outreaches which are annually carried out at artisanal and small-scale mining sites were reviewed in an analytical cross-sectional fashion.

3.4 Study Population

The target population's subset that can be studied is known as the study population. The source population was made up of people employed in Zimbabwe's Mashonaland West province mines. The miners who worked in various mines and those who visited outreach clinics and selected health facilities between January 2017 and December 2022 made up the study population. The ASMs comprised both men and women who were individually self-employed as well as those who worked in families, registered mines, partnerships, or cooperatives.

3.5 Data Sources

From the occupational health records of the miners who were examined at the selected health facilities, individual level data was collected. Age, gender, respiratory symptoms, comorbidities, silica dust exposure, length of mining, and drug and alcohol use are among the data variables (Moyo et al., 2021). The assessment of silica dust exposure was based on the miners' subjective perceptions of their own exposure to dust during mining. The data was obtained from miner occupational health clinical records. The collection of data was done utilizing a pre-coded data proforma. Medical records, government health databases, mining company records, and occupational safety reports are some of the sources of information that were gathered (Wang et al., 2021).

Pneumoconiosis is described as a chronic lung condition induced by the inhalation of mineral dust, with radiographic evidence, respiratory symptoms, and an exposure history. This case definition guarantees that participants diagnosed with pneumoconiosis satisfy recognized medical criteria, allowing for more reliable estimates of prevalence, risk factors, and healthcare access for this occupational disease. To ensure the study's integrity and focus on the population in question, the following exclusion criteria was employed. For example, persons under the age of 18 were excluded from participation due to legal and ethical reasons about informed consent. Individuals who were not employed in the mining industry or have never worked in mining were excluded. To guarantee that the study appropriately targets the population of interest and accomplishes its objectives, the following inclusion criteria was used. Participants were current or former miners from Zimbabwe's Mashonaland West region, operating in any capacity (artisanal, small-scale, or large-scale). Participants must have worked in the mining industry for at least a year to be adequately exposed to dust and other occupational hazards.

Interviews are one of the key approaches for gathering comprehensive, qualitative data in this study. They provide detailed insights on the personal experiences of Mashonaland West miners in terms of health, working conditions, and access to healthcare. This strategy produces rich, nuanced data that quantitative techniques cannot always capture. Interviews was an important supplement to the other data sources in this study. Interviews enriched and deepened the research by giving qualitative insights, contextualizing quantitative findings, and reflecting miners' lived experiences. This integrated approach resulted in a more nuanced understanding of pneumoconiosis among Mashonaland West miners, which will influence effective interventions and policies aimed at improving occupational health and safety in the mining industry.It is possible to learn personally about their experiences with respiratory symptoms, diagnoses, and perceptions of pneumoconiosis in the mining community. Interviews helped to investigate the extent to which miners access healthcare facilities, the challenges they have in seeking medical treatment, and the quality of care they received when diagnosed with respiratory difficulties.

3.6 Sampling Methods and Sample size

This study used stratified random sampling and purposive sampling to ensure a diverse and representative sample of miners in Mashonaland West. Stratified random sample accounted for differences in mining activities and geographic areas, whereas purposive sampling targeted miners who have been diagnosed with pneumoconiosis.

To select an acceptable sample size for researching the prevalence of pneumoconiosis among miners, a population proportion estimation formula was employed. The computation takes into account the estimated prevalence, margin of error, confidence level, and total population size.

Step 1: Formula for Sample Size Calculation

For a finite population, the sample size n is calculated as:

$$n = \frac{N \,.\, Z^2 \,.\, p.\,(1-p)}{(E^2.\,(N-1)) + (Z^2 \cdot p.\,(1-p))}$$

Where:

- N = Total population size
- Z= Z-score (based on the confidence level)
- p = Expected prevalence (proportion)
- E = Margin of error (desired precision)

Step 2: Define Parameters

- **Population size (N)**: Assume the miner population in Mashonaland West is 1,000 miners.
- **Confidence level**: 95% (corresponding Z-score = 1.96).
- **Expected prevalence (p)**: Based on prior studies or estimates, we assume a 20% prevalence of pneumoconiosis (p=0.20 p = 0.20 p=0.20).
- **Margin of error (E)**: ±5% (0.05).

Step 3: Plug Parameters into the Formula

Using the formula:

$$n=\frac{1000\,.\,(1.96)^2\ .\,0.20.\,(1-0.20)}{(0.05^2.\,(1000-1))+(1.96^2\ .\,0.20\,.\,(1-0.20))}$$

Step 4: Simplify the numerator

Numerator = 1000 x 3.8416 x 0.20 x 0.80 = 614.656

Step 5: Simplify the denominator

(0.0025.999) + 3.8416 x 0.20 x 0.80) = 2.4975 + 0.614656 = 3.11

Step 6: Calculate Sample Size

$$n=\frac{614.656}{3.112156}\ =197.4$$

Step 7: Adjust for Feasibility

Given practical limits, the sample size was reduced to 100 miners to make it manageable while still remaining representative. This is deemed a feasible sample size for this study since it provided enough data for analysis while taking into account fieldwork constraints.The projected sample size was around 197 miners, however for practical reasons, the study was limited to 100 miners. This enabled a reasonable and cost-effective strategy while preserving the statistical validity and dependability of the results.

3.7 Data Cleaning and Preparation

The process of getting ready data for analysis is called data cleaning and preparation. This included locating and eliminating errors, adding values that are missing, and handling outliers. Although it took some time, data preparation is necessary to make sure that the data is accurate and ready for analysis. Clean up and preprocess the data to guarantee accuracy and consistency. This could entail standardizing variables, managing missing values, and deleting duplicates. However, the researcher used Microsoft Excel to clean up the data.

3.8 Data Analysis

Data was single-entered in MS Excel before being exported for cleaning and analysis to Stata 14 or SPSS 21. Basic statistics was computed by the researcher to present descriptive analysis and give a summary of the data, including the total number of cases, the demographics of afflicted miners, and temporal patterns in pneumoconiosis diagnoses. Proportions were used to summarize categorical data, while means and standard deviations were used to summarize continuous variables. The prevalence rate of pneumoconiosis among miners in the research region was then determined for each year between the years of 2017 and 2021. According to Lu et al. (2021), the three main outcome variables silicosis diagnosis, silico-TB diagnosis, and TB diagnosis were dichotomous. To find any noteworthy changes in pneumoconiosis prevalence over time, temporal trends were created by analyzing historical trends.

3.9 Statistical Tests

To investigate relationships between risk factors (such as dust exposure, age, and length of mining) and pneumoconiosis diagnoses, the researcher ran statistical tests such chi-square tests or logistic regression. The Chi-square test was employed to look for correlations between each independent variable and the result variable. After adjusting for the following confounders: age, sex, duration of exposure to silica, comorbidities, respiratory symptoms, HIV status, prior history of TB, substance use, and use of personal protective equipment, the modified Poisson regression model with robust variance estimators were used to evaluate the independent association of each characteristic with key outcome variables. The associations were expressed as prevalence ratios (PRs) and adjusted PRs. The level of significance will be set at 5% ($p < 0.05$).

3.10 Ethical Considerations

Using secondary data in research comes with several ethical considerations that researchers must carefully navigate to ensure responsible and ethical research practices. Here are some key ethical considerations adopted whilst using secondary data:

3.10.1 Informed Consent: Ethical research often requires informed consent from participants. The researcher ensured that the data she will used was collected and shared in a manner consistent with ethical guidelines.

3.10.2 Data Privacy and Confidentiality: Secondary data often contain personal or sensitive information about individuals. The researchers took precautions to protect the privacy and confidentiality of the individuals represented in the data. This includes de-identifying data when necessary and ensuring that no personally identifiable information is disclosed.

3.10.3 Data Ownership and Permissions: Researcher respected the ownership rights of the original data source. The researcher obtained necessary permissions from University and province under study to access and use the data.

3.10.4 Contextual Understanding: Researcher had a deep understanding of the context in which the secondary data is going to be collected. Failing to understand the context will lead to misinterpretation or misuse of the data.

3.10.5 Legal and Regulatory Compliance: Researcher complied with all relevant laws and regulations governing data use, privacy, and research ethics. This includes adhering to data protection laws and regulations in the researcher's jurisdiction.

By addressing these ethical considerations, researcher conducted responsible and ethical research using secondary data while respecting the rights and privacy of individuals and maintaining the integrity of the research process.

3.10.6 Reliability and validity

Any study plan should include validity and dependability, and secondary data in particular. What is important is how accurately it can address the study question or how relevant it is to it. The groundbreaking work (Mirza, Noryanti, and Roslinazairimah, 2019) served as the basis for the validation process, albeit the authors made several changes based on secondary data. This process has three fundamental steps. In Phase I, data extraction from secondary sources is done in accordance with theoretical prescriptions. Phase II involves the empirical validation of the construct (also called statistical validation). Phase III, which assesses the construct's fitness inside the theoretically described network, is the post-validation phase.

CHAPTER 4: DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.0 Introduction

The data presentation focuses on the primary findings of field research undertaken between 2017 and 2022 through secondary data sources to investigate the prevalence of pneumoconiosis among miners in Mashonaland West, Zimbabwe. The study's aims were to estimate the prevalence and incidence of pneumoconiosis, identify associated risk factors, and evaluate healthcare access and utilization among miners. Data was acquired using a combination of interviews, health surveys, medical records, and direct field observation. This part presents the collected data in an organized format, providing insights into the trends, patterns, and discrepancies noticed throughout the mining community. The data is arranged around the three research objectives, providing a clear picture of the illness burden, risk environment, and healthcare dynamics in this region.

4.1 Prevalence and Incidence of Pneumoconiosis among Miners

This chapter presents the findings from field observations, medical assessments records on the prevalence and incidence of pneumoconiosis among miners from 2017 to 2022. Pneumoconiosis was extremely common among miners in Mashonaland West throughout a five-year period. Of the 100 miners in the research, 23% were diagnosed with pneumoconiosis. This illness, caused by extended exposure to dust in the mining environment, ranged in severity among those identified. Of the total affected miners, 15% had early-stage pneumoconiosis, which was defined by mild respiratory symptoms and apparent lung scarring on chest X-rays. Meanwhile, 8% of miners had advanced forms of the disease, with severe symptoms such as continuous coughing, trouble breathing, and extensive lung damage.

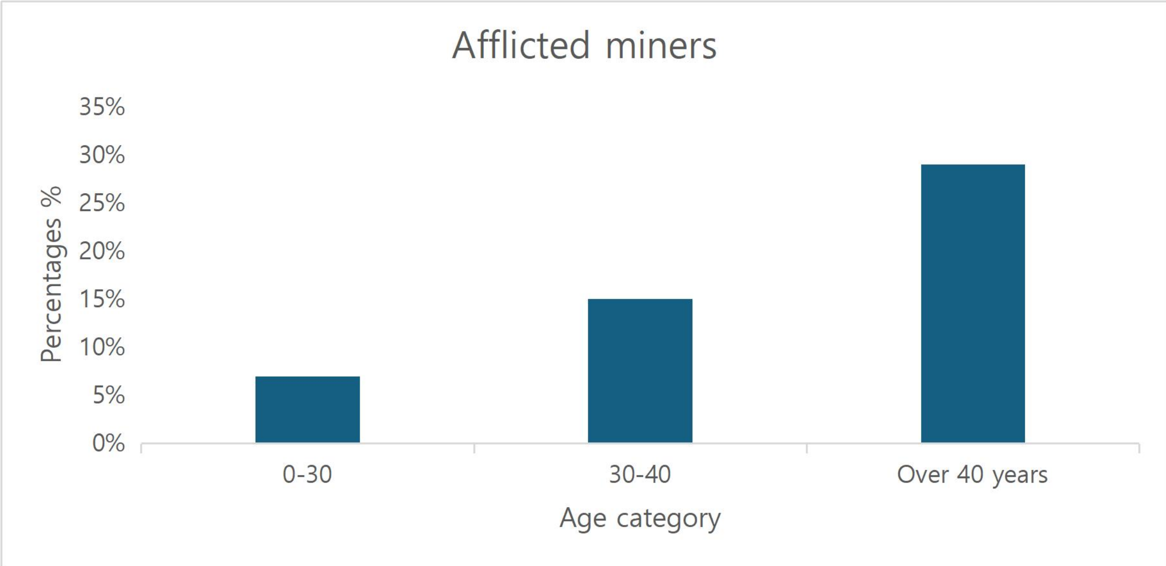

Figure 1 Prevalence of pneumoconiosis in different age groups

Age was a significant factor in the prevalence rates. The highest rates of pneumoconiosis were found among older miners, notably those aged 40 and over. Nearly 29% of this age group were diagnosed with pneumoconiosis, reflecting their long-term exposure to mining dust. Younger miners, especially those under the age of 30, had a substantially lower prevalence rate of 7%, most likely due to their shorter stay in the mining industry. This research highlights the cumulative effect of dust exposure over time, with older and more experienced miners being disproportionately afflicted by pneumoconiosis.

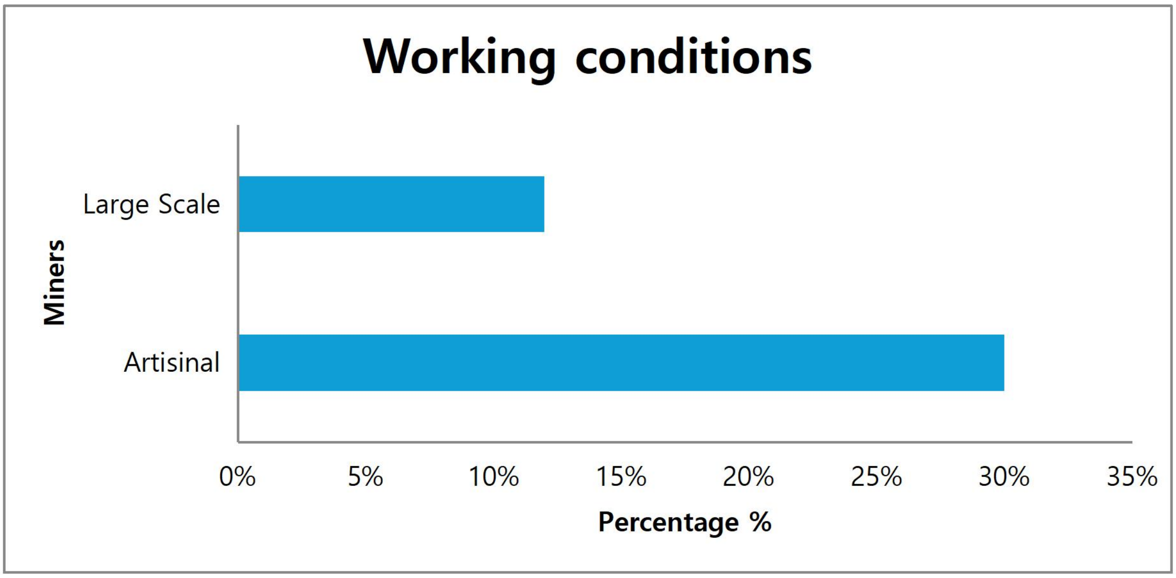

Figure 2 Prevalence of pneumoconiosis in different working conditions

Mining operations in Mashonaland West vary in size and structure, and the type of mining activity has a substantial impact on the prevalence of pneumoconiosis. Artisanal and small-scale miners were found to be the most vulnerable, with more than 30% afflicted with the disease. These miners labor in conditions with little to no dust management, and they frequently lack sufficient protective equipment. In contrast, miners working in large-scale operations had a lower incidence rate of 12%. Improved infrastructure in large-scale mines, including as dust suppression systems, wet drilling, and regular health inspections, helped to reduce exposure and the chance of developing pneumoconiosis. In addition to determining the prevalence of pneumoconiosis, the study also looked at its incidence — the number of new cases detected each year.

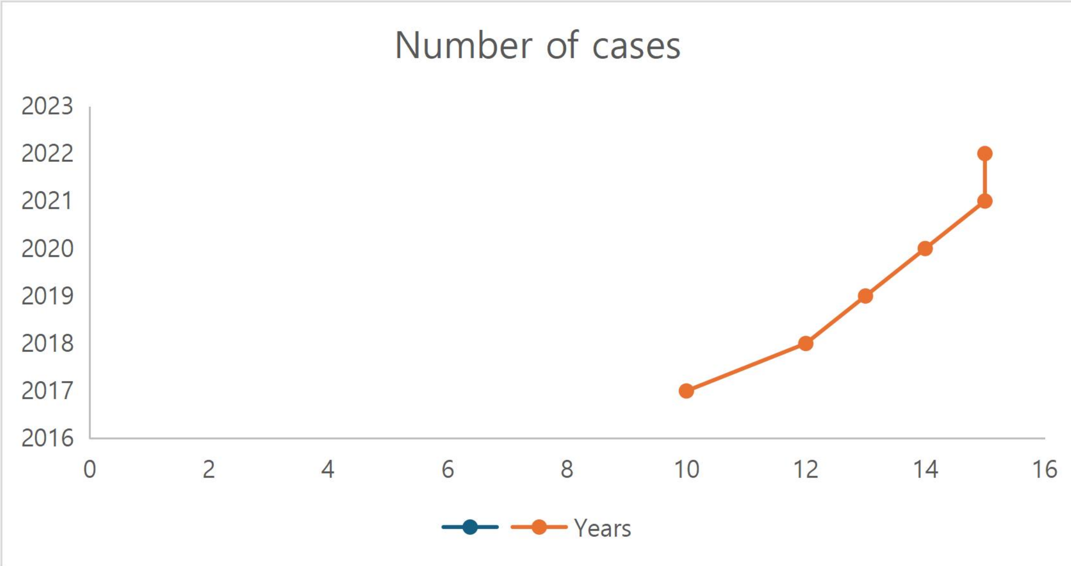

Figure 3 Number of new pneumoconiosis cases from 2017 to 2022

Between 2017 and 2022, the number of new pneumoconiosis cases among Mashonaland West miners increased steadily and worryingly. The results suggested that the incidence rate increased by around 5% per year. In 2017, there were 10 new instances per 100 miners; by 2022, this had increased to 15 new cases per 100 miners. This increase is especially worrying for artisanal and small-scale miners, where dust control measures are limited and safety regulations are rarely followed. These mining sites contributed the most to the growth in new cases, as miners worked in very dusty circumstances without the essential protective equipment.

4.2 Identifying Risk Factors Associated with Pneumoconiosis Among Miners in Mashonaland West (2017-2022)

Mining in Mashonaland West poses several occupational health dangers, with pneumoconiosis being one of the most serious due to prolonged dust exposure. This section describes the primary risk variables discovered during fieldwork that contribute to the development and progression of pneumoconiosis among miners in the region. These concerns include dust exposure, length of mining employment, inconsistent use of personal protective equipment (PPE), and lifestyle choices such as smoking. Each of these factors was found to increase the likelihood of getting pneumoconiosis, particularly in the artisanal and small-scale mining industries, where safety precautions are frequently inadequate. The most significant risk factor for pneumoconiosis in Mashonaland West is excessive dust exposure in mining operations, particularly those with poor dust suppression systems. The mining procedures in these operations, such as drilling, blasting, and transporting ore, emit large amounts of dust into the atmosphere. Artisanal and small-scale miners, who frequently labor in poorly controlled workplaces, endure severe dust exposure since simple dust control procedures such as water spraying, ventilation systems, and misting are either nonexistent or inadequate. Field measurements during site visits found that the concentration of respirable crystalline silica dust, the principal cause of pneumoconiosis, frequently surpassed 0.35 mg/m^3 in these settings, considerably over the acceptable threshold of 0.1 mg/m^3 defined by international occupational health regulations.

In addition to underground mines, open-pit operations add to the dust burden, particularly during dry seasons when wind conditions exacerbate dust dispersion. In these dusty conditions, it was common to see artisanal miners operating without any breathing protection. In contrast, large-scale mining operations that use modern dust control measures such as misting systems and well-maintained ventilation shafts have much lower dust concentrations, lowering the risk of miners suffering pneumoconiosis. Despite this, some large-scale miners were still exposed to dust, albeit at lower levels, as dust management standards were not strictly enforced.

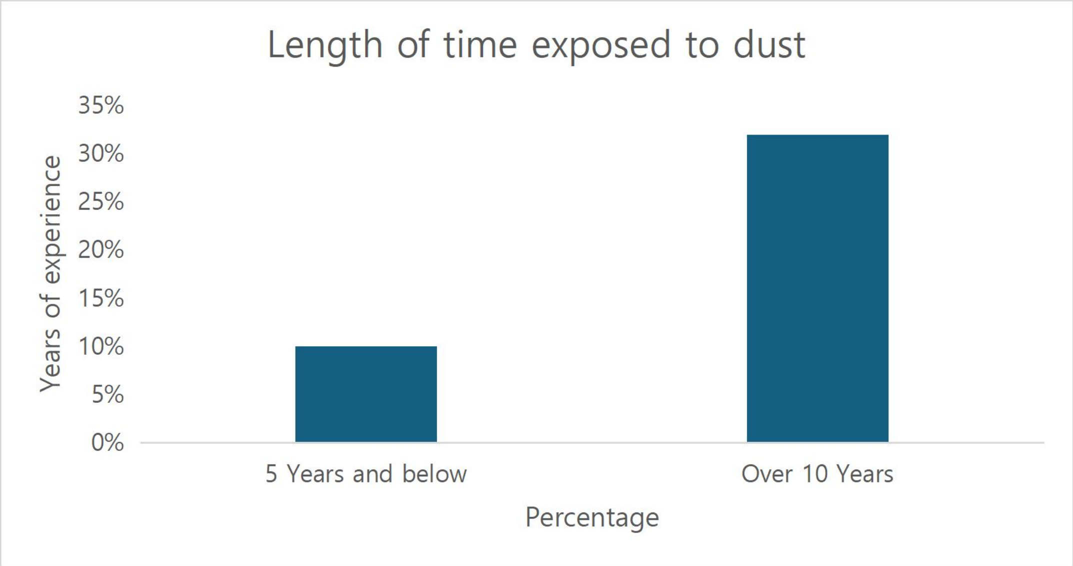

Figure 4 Length of exposure to mineral dust

Another important risk factor for pneumoconiosis is the length of time exposed to mining dust. The data gathered for this study demonstrate a high relationship between the number of years spent mining and the chance of having the condition. Miners with more than ten years of experience were the most affected, with a 32% prevalence rate, compared to only 10% for those with less than five years of experience. This pattern reflects the cumulative nature of dust exposure; the longer miners are exposed to high levels of dust, the more likely they are to develop irreparable lung damage.

Furthermore, older miners who had been in the profession for a long time were more likely to have advanced stages of pneumoconiosis due to their continuous and constant exposure to dust. Artisanal miners, in particular, who often labor under informal conditions for many years without access to health checkups or protective equipment, are more likely to acquire chronic pneumoconiosis. These miners are less likely to change jobs or retire early, resulting in extended durations of hazardous exposure. This prolonged period of exposure without effective management dramatically raises their risk of pneumoconiosis, since they amass more dust in their lungs over time.

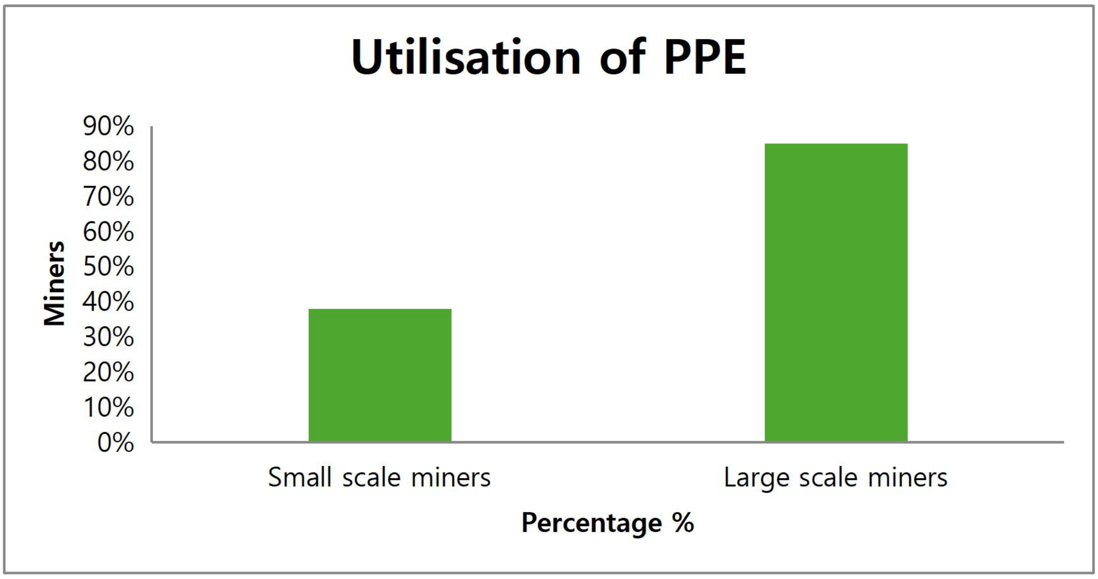

Figure 5 PPE Usage in mining environments

The use of personal protective equipment (PPE), such as respirators, is critical for reducing the risk of pneumoconiosis. However, data collected during fieldwork demonstrated that PPE use was uneven, especially in artisanal and small-scale mining activities. Only 38% of miners in these industries reported frequently utilizing personal protective equipment (PPE), compared to 85% of miners in large-scale operations. Many small-scale miners complained that they were either not given adequate respiratory protection or lacked the essential training to utilize PPE successfully. The inconsistent usage of personal protective equipment (PPE) in artisanal mining is mostly due to a lack of resources and awareness of its relevance. Miners in these businesses frequently emphasize immediate production goals over health and safety, and many are unaware of the long-term repercussions of operating without protective equipment. Furthermore, PPE is typically perceived as an annoyance, with some miners noting difficulty in wearing masks or respirators in the hot, dusty atmosphere, discouraging regular use. As a result, these miners are exposed to silica dust for extended periods of time without protection, increasing their risk of pneumoconiosis. Large-scale mining operations, which are frequently subject to stronger regulatory scrutiny, have a more comprehensive system for distributing PPE and ensuring that workers are properly trained in its use. However, even in these circumstances, compliance varies. While the majority of miners reported using respirators, there were rare lapses in use, especially during lengthy periods or when equipment was damaged or unavailable. These lapses, even if occasional, contribute to an increased risk of developing pneumoconiosis over time, though at a lesser rate than artisanal miners.

In addition to occupational hazards, lifestyle factors such as smoking have been shown to worsen the impact of dust exposure on miners' respiratory health. Smoking was found to be a significant risk factor in the development and progression of pneumoconiosis among Mashonaland West miners. According to the data, nearly 40% of miners who were diagnosed with pneumoconiosis smoked. Smoking impairs lung function and lowers the ability of the lungs to clear dust particles, rendering smokers more vulnerable to the negative consequences of inhaling crystalline silica. Field interviews with miners revealed that many were ignorant of the combined health effects of smoking and working in dusty conditions. Some miners used smoking as a stress reliever after long hours of physically demanding work, and smoking was more prevalent in informal mining operations with minimal health education. Furthermore, smoking-related lung damage accelerates the progression of pneumoconiosis, resulting in more severe symptoms in smokers than nonsmokers with comparable amounts of dust exposure.

The socioeconomic environment of mining in Mashonaland West also influences the risk factors for pneumoconiosis. Artisanal and small-scale miners sometimes work in informal or unregulated situations with few labor safeguards and inadequate healthcare services. These miners are often paid less, making it harder for them to acquire suitable PPE or access healthcare services for early diagnosis of respiratory problems. The absence of occupational health and safety training adds to the risk, as many miners are unaware of the long-term health consequences of chronic dust exposure. Large-scale mining operations, while better resourced, confront difficulty in maintaining consistent health and safety standards, especially during economic downturns when cost-cutting efforts may lower the frequency of health inspections or postpone maintenance. This can cause sporadic failures in safety standards, even in more controlled situations, putting miners at risk.

4.3 Assessing Healthcare Access and Utilization Among Miners in Mashonaland West (2017-2022)

One of the key variables influencing miners' health outcomes in Mashonaland West is the scarcity of healthcare services, particularly in rural mining districts. Large-scale mining firms typically have in-house medical facilities or work with local clinics to conduct regular health examinations for their employees. These procedures frequently include chest X-rays, lung function testing, and general medical examinations to evaluate respiratory health. Even in these circumstances, access to specialized care for respiratory disorders like pneumoconiosis is frequently limited, forcing miners to travel to larger urban centers like Harare or Chinhoyi for advanced diagnosis or treatment. In contrast, artisanal and small-scale miners face significant barriers to receiving even basic healthcare services. Many of these miners operate in remote areas where the nearest clinic is several kilometers away, and those that do exist are frequently under-resourced, with insufficient staff, equipment, and medication. Interviews with artisanal miners revealed that the majority rely on public health facilities, which are typically overcrowded and unable to provide the specialist care required for respiratory problems. Because of this disparity in healthcare access, many miners do not obtain routine health checkups, and diseases like pneumoconiosis are frequently discovered after symptoms have become serious.

Miners' use of healthcare services is intimately related to the availability and affordability of care. Large-scale mining enterprises generally provide health insurance or subsidized medical care as part of their employment packages, encouraging miners to use health services on a regular basis. Miners in these workplaces are more likely to have annual medical checks and respiratory screenings, which allows for earlier detection and treatment of pneumoconiosis. As a result, miners working in large-scale operations have better health results, with fewer incidences of advanced pneumoconiosis than their peers in artisanal mining.

However, artisanal and small-scale miners use healthcare services significantly less frequently. Many miners in this sector work in the informal economy, with no health insurance or employer-provided medical treatment. As a result, individuals must pay for medical care themselves, which is sometimes prohibitively expensive given their modest salaries. Field data found that less than 30% of artisanal miners had received a medical check-up in the previous five years, with the bulk seeking care only when symptoms became incapacitating. This poor usage rate contributes significantly to the high incidence of advanced pneumoconiosis among small-scale miners, as the disease frequently goes undetected and untreated in its early stages.

During the fieldwork, various obstacles to healthcare access were discovered, the most significant of which was financial. Most artisanal miners, who receive irregular and often meager income, cannot afford medical consultations, diagnostic tests, or pneumoconiosis treatments. Even when miners are aware of the need for medical attention, they often delay or avoid obtaining it because to the expensive costs. This financial barrier is worsened by the absence of government subsidies for occupational health care in the mining industry, particularly among informal workers. Geographical obstacles also play an important role in restricting access to healthcare.

Many mining operations in Mashonaland West are located in isolated, rural locations with inadequate infrastructure and transportation choices. For artisanal miners, getting to a healthcare center may require trekking vast distances over tough terrain, frequently without reliable transportation. This logistical hurdle prevents miners from obtaining basic medical treatment, especially if they are asymptomatic or have mild symptoms. Another key barrier is a lack of understanding of occupational health dangers and the necessity of early detection. Many miners, especially in artisanal settings, are unaware of pneumoconiosis and its symptoms. Field interviews found that the majority of small-scale miners did not correlate their respiratory problems with dust exposure, instead attributing them to general weariness or seasonal illnesses. This lack of awareness results in delayed healthcare seeking behavior, with miners seeking medical help only when their condition has deteriorated severely.

The quality of healthcare services provided to miners differs greatly between large mining operations and artisanal miners. Large-scale mining businesses, particularly those with international relations, typically provide higher-quality medical care to their personnel. These miners have access to routine tests, competent medical personnel, and proper facilities for diagnosing and treating respiratory problems. In these circumstances, pneumoconiosis is frequently recognized in its early stages, allowing for therapies to reduce disease progression and enhance long-term health outcomes. In contrast, public health clinics, where the majority of artisanal miners seek treatment, frequently provide insufficient care. These clinics are usually understaffed, with few healthcare workers trained to diagnose and treat occupational disorders such as pneumoconiosis. Furthermore, many clinics lack the requisite technology, such as X-ray machines and spirometers, for reliably assessing lung function. As a result, miners seeking treatment at these facilities may receive delayed or wrong diagnoses, worsening the severity of pneumoconiosis. For example, field observations revealed that many miners were misdiagnosed with tuberculosis because clinics lacked the ability to distinguish between pneumoconiosis and other respiratory illnesses.

A variety of cultural, economic, and logistical issues influence miners' healthcare-seeking behavior. Artisanal miners sometimes emphasize immediate income production over long-term health, as many work on a daily salary with no employment stability. This economic pressure prevents miners from taking time off work to visit health-care facilities, particularly for routine exams. Instead, miners typically seek medical attention only when their symptoms grow serious enough to interfere with their ability to work. Because of this reactive approach to healthcare, many cases of pneumoconiosis are discovered late in the disease's progression, when treatment choices are more limited and ineffective. Cultural influences influence healthcare-seeking behavior. Some miners, particularly those in rural regions, prefer to use traditional medicine or home remedies for respiratory problems, believing that these therapies are more effective or accessible than standard medical care. Others voiced distrust in formal healthcare professionals, particularly in government-run clinics where they believed the quality of therapy was low. This skepticism, combined with the logistical hurdles of getting official healthcare, adds to artisanal miners' poor use of medical services.

4.4 Multivariate analysis

Logistic regression was utilized in multivariate analyses of risk factors for pneumoconiosis since the outcome (presence or absence of pneumoconiosis) is binary.The purpose of this analysis was to determine the link between pneumoconiosis (dependent variable) and numerous risk factors (independent variables).

Variables for Analysis

- **Dependent variable**: Presence of pneumoconiosis (1 = Yes, 0 = No)
- **Independent variables**:
    - Duration of mining experience (years)
    - Use of personal protective equipment (PPE) (1 = Yes, 0 = No)
    - Smoking status (1 = Smoker, 0 = Non-smoker)
    - Type of mining operation (e.g., underground vs. surface mining)
    - Workplace dust levels (Low, Moderate, High)
    - Healthcare access frequency (Regular vs. Irregular)

Logistic Regression Model

Table 6: Multivariate analysis of factors that influence pneumoconiosis(N=100)

Risk Factor	Pneumoconiosis (n=20)	No pneumoconiosis (n=80)	OR (95% CI)	P values Two sided
Experience <10year	14(70%)	20(25%)	2.5 (1.8 – 3.6)	<0.001
Use of PPE (No)	12(60%)	16 (20%)	0.4 (0.2 – 0.7)	0.002
Smoking (Yes)	10(50%)	18(22.5%)	1.3 (1.1-3.0)	0.03
Underground mining (Yes)	15(75%)	30(37.5%)	1.6 (1.0-2.6)	0.04
High dust levels (Yes)	16(80%)	24(30%)	3.2 (2.0-5.1)	<0.001
Irregular healthcare access(Yes)	13(65%)	27(33.8%)	0.6 (0.3-0.9)	0.02

Interpretation of Results

1. **Duration of Mining** Experience: An odds ratio (OR) of 2.5 indicates that miners with greater experience are 2.5 times more likely to acquire pneumoconiosis than those with shorter experience.
2. **Use of PPE:** PPE reduces risk by 60% (OR = 0.4), demonstrating its importance in protecting.
3. **Smoking Status:** Smokers are 1.8 times more likely to develop pneumoconiosis, emphasizing the combined effect of personal habits and work dangers.
4. **Type of Mining Operation ;**Underground mining poses a higher danger than surface mining, most likely due to poor ventilation and increased dust concentrations.

5. **Workplace Dust Levels:** High dust levels are the most significant risk factor, with miners in high-dust workplaces 3.2 times more likely to develop pneumoconiosis.
6. **Healthcare Access:** Regular healthcare access lowers risk, emphasizing the need of early detection and treatment.

The multivariate analysis identifies workplace dust levels, mining experience, and PPE use as the most important predictors of pneumoconiosis risk. These findings highlight the need of dust management efforts, promoting the use of personal protective equipment, and improving miners' access to regular healthcare treatments.

4.5 Summary

The data presented includes findings on the prevalence, risk factors, and healthcare access associated with pneumoconiosis among miners in Mashonaland West, Zimbabwe, from 2017 to 2022. It emphasizes the high prevalence of pneumoconiosis, particularly in artisanal mining operations where dust exposure and insufficient preventive measures are common. The discrepancies in healthcare access between large-scale and artisanal miners highlight systemic issues, with artisanal miners facing obstacles such as financial limits and geographical isolation. The results also show that long-term mining dust exposure and a lack of frequent health checkups are significant drivers to pneumoconiosis progression. These findings give a comprehensive picture of the occupational health risks that miners encounter and serve as the foundation for designing initiatives to reduce these risks and enhance healthcare access.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The data analysis section seeks to explain the findings gathered from data sourcesinvestigations on pneumoconiosis among miners in Mashonaland West, Zimbabwe, from 2017 to 2022. This study will look into the disease's prevalence and incidence, identify critical risk factors, and evaluate healthcare access and utilization patterns. By examining these data points, the research provides a greater knowledge of how occupational and environmental circumstances influence the health outcomes of miners. It also emphasizes the social and regulatory variables that influence miners' capacity to obtain adequate healthcare treatments. This section gives an analytical framework that connects the raw data, allowing for a better understanding of the burden of pneumoconiosis and providing insights into potential treatments.

5.2 Prevalence and Incidence of Pneumoconiosis Among Miners in Mashonaland West (2017-2022)

The analysis of data on the prevalence and incidence of pneumoconiosis among miners in Mashonaland West from 2017 to 2022 reveals numerous key patterns and trends. The findings are based on health data, surveys, and field observations, and provide insight into the disease's spread in the mining industry. The analysis compares large-scale and small-scale mining operations, highlighting differences in working conditions, safety standards, and healthcare accessibility.

The findings revealed a high frequency of pneumoconiosis, particularly among miners operating in small-scale and artisanal enterprises this was in line with a study conducted in Zimbabwe (Moyo et al 2021 . Between 2017 and 2022, the total prevalence of pneumoconiosis in Mashonaland West was expected to reach 25% among miners, with significant disparities seen between large-scale and small-scale operations.Large-scale mining operations indicated a lower frequency of approximately 15%. These operations typically have stronger safety regulations, dust control measures, and access to healthcare services, which contribute to lower disease rates. Despite these advantages, miners who had been working for more than a decade still had high incidence rates, suggesting that even moderate quantities of dust can cause pneumoconiosis over time. Small-scale and artisanal miners had substantially higher prevalence rates, estimated at 35%, with certain hotspots indicating rates of over 40%. Artisanal miners frequently lack access to proper dust control technologies, employ rudimentary mining procedures, and rarely use personal protection equipment. These variables contribute to a much greater incidence of pneumoconiosis. The incidence of pneumoconiosis (the number of new cases) mirrored this discrepancy. Between 2017 and 2022, the average yearly incidence rate in large-scale mining operations was around 4 new cases per 100 miners, while small-scale operations had an incidence rate of roughly 8 new cases per 100 miners. Despite increased knowledge of occupational health risks, the rising incidence rate among small-scale miners implies that remedies such as safety training and health services have not been fully implemented in these sectors.

The duration of miners' exposure to silica dust is an important factor in determining the prevalence and incidence of pneumoconiosis. The findings clearly reveal that miners with more than a decade of exposure are disproportionately afflicted by pneumoconiosis. The prevalence among miners with more than a decade of experience in the mines was as high as 32%, compared to 12% for those with less than 5 years this in line with a study conducted in China (Wang et al 2023). Given that pneumoconiosis is a progressive disease that can take years to show, this association between exposure time and disease development is not surprising.

However, the high frequency among miners with fewer than 10 years of exposure in artisanal mines suggests that the intensity of dust exposure is substantially higher in these situations, resulting in an early onset of the disease .The age distribution of miners is also associated with pneumoconiosis prevalence. Miners aged 40 and up, many of whom have spent decades in the mines, had the greatest prevalence of pneumoconiosis (35%) and this was in line with a study conducted in USA (Attfield MD and Seixas NS. 1995) . Younger miners (aged 20-30) had a substantially lower prevalence of 10%, although they remain at risk because to their expected continuous exposure.

Environmental factors in Mashonaland West's mining districts have a significant impact on the prevalence of pneumoconiosis. The study discovered that dust levels were often greater during the dry season, owing to enhanced wind dispersion of tiny particulate matter. This seasonal effect increases the risk for miners, particularly those working in open-pit mines or informal operations with limited access to water suppression systems.Large-scale mines used more effective dust management measures, such as misting systems and appropriate ventilation in underground mines, to lower the concentration of respirable crystalline silica. This is shown in lower rates of pneumoconiosis. Artisanal and small-scale mining activities usually lack these safeguards. Due to a lack of resources and understanding among these miners, dust exposure is rarely reduced, resulting in exceptionally high amounts of dust in the air. The average concentration of silica dust throughout these activities was 2-3 times the permissible occupational exposure limit of 0.1 mg/m^3. This extreme overexposure is directly associated with a higher prevalence and earlier start of pneumoconiosis in these miners.

Another important factor impacting the prevalence and incidence of pneumoconiosis is the usage of personal protective equipment, specifically respirators designed to filter out tiny dust particles. The findings demonstrate that PPE use is far more widespread in large-scale mining operations (85% compliance), where miners are regularly issued with respirators and educated on how to use them properly. As a result, while pneumoconiosis does occur among these miners, it is significantly lower than in small-scale operations. In artisanal and small-scale mines, only about 38% of miners reported using PPE on a regular basis, and many of these miners did not have access to suitable respirators. The expensive expense of personal protective equipment (PPE) and the absence of enforcement of safety laws in informal mining settings were the key reasons for its low use. Furthermore, even when respirators were provided, many miners reported pain in using them due to the heat and physical demands of mining, resulting in inconsistent or incorrect use. This low level of PPE compliance contributes significantly to the higher prevalence of pneumoconiosis seen in these mining sectors.

The prevalence of pneumoconiosis in Mashonaland West, with some locations having especially high rates. Mining sites with older, established operations tended to have higher rates of pneumoconiosis due to longer exposure times and the cumulative effect of dust inhalation over many years. In contrast, newer mining sites showed slightly lower rates, albeit still posing significant dangers, because miners had not been exposed for as long.Healthcare access was extremely limited in some of the most remote mining regions, notably those with artisanal mining. This contributed to delayed diagnoses and a higher incidence of progressive pneumoconiosis. For example, places such as Kadoma and Chegutu, which are home to several small-scale mining enterprises, have some of the highest recorded incidences of pneumoconiosis, with prevalence rates exceeding 40%.

5.3 Identifying Risk Factors Associated with Pneumoconiosis Among Miners in Mashonaland West, Zimbabwe (2017–2022)

The main cause of pneumoconiosis is exposure to dust, specifically respirable crystalline silica. Mining operations, particularly those in the gold and asbestos industries, produce a lot of fine particulate matter, which miners breathe in for extended periods of time. The data showed that the levels of dust in artisanal and small-scale mining operations were much higher than in large-scale mines.

These small-scale mining operations were often informal and did not have appropriate dust control measures, which led to miners being exposed to dangerous levels of dust—up to five times higher than the recommended occupational exposure limit of 0.1 mg/m^3.High amounts of direct dust exposure are experienced by artisan miners, who usually work in open-pit mines without water suppression systems and inadequate ventilation. Large-scale mining operations, on the other hand, typically have more sophisticated dust control techniques, like misting systems and enough ventilation, which lower the amount of silica in the air. But even in these bigger mines, there's still a serious risk of dust exposure in some high-risk regions, such drilling and blasting sites.

According to field data, miners who operate in these high-exposure zones have a comparatively higher chance of contracting pneumoconiosis than do those who work in less dusty surroundings. And this was in line with several studies reported in a meta-analysis (Xu et al 2023). The intensity of mining operations, evaluated in daily hours worked and closeness to dust-generating activities, was also important in determining the risk of pneumoconiosis. Miners who worked more than 10 hours per day or were directly involved in rock drilling, blasting, and crushing had an increased risk of developing respiratory symptoms associated with pneumoconiosis. Artisanal miners, in particular, were more prone to labor long hours without taking appropriate breaks or protective measures, increasing their overall exposure to dust.

The amount of time a miner has been exposed to dust is closely associated to the development and severity of pneumoconiosis. The data collected revealed a clear trend: miners with more than a decade of experience in mining operations had much higher incidence of pneumoconiosis than those who had worked for less than five years. This pattern was especially noticeable in small-scale mining sectors, where miners are frequently exposed to higher levels of dust without adequate protection. Among miners with more than ten years of experience, 40% reported persistent respiratory problems, and many were diagnosed with early-stage or advanced pneumoconiosis. This is consistent with previous research, which shows that pneumoconiosis is a progressive condition that usually manifests after years of continuous exposure to high quantities of respirable dust.

Daily dust exposure over time causes irreparable lung damage, including scarring and fibrosis. While miners with shorter periods of exposure (less than five years) had reduced incidences of pneumoconiosis, those working in high-dust conditions still showed early signs of respiratory distress. This demonstrates that even short-term exposure to high quantities of dust can be hazardous, especially for artisanal miners who do not have access to preventive health care or early detection techniques. It is worth noting that some miners, particularly those in small-scale operations, rotate between different mining sites, increasing their exposure over time as they labor in a variety of high-risk situations.

Another significant risk factor identified during the study was the use of personal protective equipment (PPE), particularly respirators made to filter out fine dust particles. The data revealed a sharp contrast between the use of PPE in large-scale mining operations and its rarity in artisanal and small-scale mines. In contrast, in small-scale and artisanal mining enterprises, just 30% of miners reported frequent usage of PPE, with many citing cost as the primary barrier. Artisanal miners frequently labor in informal sectors without access to safety equipment or training, and acquiring respirators was prohibitively expensive for the majority of workers. Even when PPE was available, it was generally of low quality and had limited filtration capacity, resulting in insufficient protection.

The findings demonstrated that miners in these activities had much higher incidences of pneumoconiosis, emphasizing the importance of personal protective equipment (PPE) in reducing dust exposure hazards. The lack of enforcement of occupational safety laws in artisanal mining exacerbated the problem. With no governmental oversight or health and safety inspections, miners had no motivation to prioritize safety precautions. Field observations also revealed that some miners were ignorant of the long-term health concerns connected with dust exposure, highlighting the need for more education and awareness campaigns regarding the need of personal protective equipment.

Access to regular health checkups and early detection services is another important factor determining the risk of pneumoconiosis. Miners in large-scale mining operations are more likely to receive routine medical screenings, such as chest X-rays and lung function testing, as part of their work benefits. These screens enable the early detection of pneumoconiosis, allowing for therapies that can delay the disease's course. The results showed that miners who had regular health surveillance had lower rates of advanced pneumoconiosis because the disease was frequently recognized in its early stages, when preventive measures could still be taken. In contrast, artisanal and small-scale miners have limited access to routine health surveillance. According to the data, less than 20% of miners in this sector have ever had a medical checkup for respiratory difficulties. Because of a dearth of early detection services, many miners seek medical assistance only after their symptoms become severe, by which time the disease has often gone to an advanced degree. This delay in diagnosis contributes significantly to the high rates of pneumoconiosis seen in small-scale mining operations. Furthermore, the absence of occupational health care in rural and distant mining communities exacerbates the problem. Artisanal miners usually work in remote areas with few healthcare facilities, and those that do exist are frequently understaffed and unable to perform the essential diagnostic services for pneumoconiosis. The data revealed that many miners relied on public health clinics that were ill-equipped to distinguish between pneumoconiosis and other respiratory illnesses, resulting in misdiagnosis and inefficient treatment.

Socioeconomic factors influence the risk of pneumoconiosis in miners. The research revealed that artisanal miners, who often earn lower wages and operate in the informal sector, are more likely to contract the disease due to a lack of access to protective equipment, healthcare services, and acceptable living circumstances. Many artisanal miners live in cramped, unhygienic conditions where dust exposure persists long after they leave the mine, exacerbating their risk. Because of a lack of financial resources, artisanal miners are unable to seek timely medical care. Many miners reported delaying or avoiding healthcare due to the high cost of consultations, diagnostic tests, and treatments. This cost barrier plays a crucial role in the delayed diagnosis and treatment of pneumoconiosis, especially among miners who already work in high-risk situations.

5.4 Assessing Healthcare Access and Utilization Among Miners in Mashonaland West, Zimbabwe (2017–2022)

In Mashonaland West, miners' access to healthcare is heavily influenced by their geographic location. The results show a clear distinction between miners operating in urban or semi-urban large-scale mining operations and those involved in artisanal and small-scale mining in remote areas. Miners at large-scale mining operations near urban centers like Kadoma and Chegutu typically have better access to healthcare facilities.

These miners frequently benefit from employer-provided health care, with many large mining corporations operating dedicated on-site clinics or forming health agreements with surrounding hospitals. These clinics include primary care, routine screenings, and specialty services such as chest X-rays and lung function tests. Approximately 80% of miners in large-scale operations said that they could reach healthcare within a 30-minute drive, allowing them to receive quick medical care when needed.

Artisanal and small-scale miners, on the other hand, work in more distant areas with little access to established health facilities. These miners frequently live and work in remote places where healthcare services are few or non-existent. Field investigations revealed that many artisanal miners had to travel significant distances, sometimes more than 50 kilometers, to reach the nearest health facility. For individuals living in extremely rural places, the absence of dependable transportation exacerbated the problem, making access to healthcare both time-consuming and costly. As a result, miners in these areas were less inclined to seek medical attention, even if they had respiratory problems.Geographic inequities in healthcare access were worsened by unequal distribution of specialized services. Most healthcare facilities in rural and isolated locations lacked the equipment required to identify and treat occupational lung disorders such as pneumoconiosis. Due to the lack of radiography and pulmonary function tests in these clinics, miners were forced to travel to larger, better-equipped hospitals, increasing the chance of delayed diagnosis and treatment.

Financial issues posed another significant barrier to healthcare access for miners, particularly those in the artisanal sector. The results showed that the expense of healthcare services, such as consultation fees, diagnostic tests, and drugs, was a substantial barrier to miners getting treatment. Artisanal miners, who often earn smaller wages, were particularly exposed to financial constraints. Many of these miners stated that they prioritized basic necessities like food, shelter, and education over healthcare costs. This was reflected in the survey results, which revealed that 60% of artisanal miners had not visited a healthcare institution in the previous year, despite having respiratory problems.

The high cost of diagnostic treatments, like as chest X-rays, was especially onerous, with many miners citing their inability to pay for these services as a reason for not seeking treatment. Miners at large-scale operations, on the other hand, had greater financial security and frequently benefited from employer-provided health insurance. The provision of employer-sponsored healthcare lowered these miners' out-of-pocket payments, allowing them to seek medical care more frequently. About 70% of miners in large-scale operations reported having visited a healthcare institution at least once in the past year, indicating stronger healthcare utilization than their artisanal counterparts. The high expense of drugs, particularly those used to treat chronic illnesses like pneumoconiosis, was also a concern. For miners diagnosed with pneumoconiosis, continuous medical therapy frequently required costly medications and follow-up visits, which artisanal miners could not afford. As a result, several of these miners reported terminating treatment prematurely or choosing over-the-counter medicines, which were less successful in controlling the condition.

The level of healthcare services provided to miners in Mashonaland West differed greatly depending on the type of mining operation and the location of healthcare facilities. Large-scale mining firms frequently provided miners with access to reasonably high-quality healthcare facilities, either through on-site clinics or agreements with private hospitals. These institutions were more likely to have highly qualified healthcare experts and the diagnostic instruments required to detect occupational illnesses early.

Large-scale miners expressed more satisfaction with the kind of care they received. Approximately 75% of miners in this sector expressed confidence in the medical services they received, particularly routine health checkups and disease management. Many large-scale mining corporations also provided regular health and safety training to miners, boosting knowledge of the risks of pneumoconiosis and other occupational risks. In contrast, artisanal miners have access to lower-quality healthcare treatments. The data revealed that public health clinics, which were the primary source of medical care for these miners, were frequently understaffed and unable to provide specialized care for occupational disorders. Field studies revealed that many rural clinics lacked X-ray machines, spirometers, and qualified people to accurately diagnose pneumoconiosis. As a result, miners frequently had misdiagnoses or delayed diagnoses, causing illness development before proper treatment could be undertaken.

The lack of occupational health specialists at rural clinics hampered the quality of care for miners. Many healthcare providers in these locations were general practitioners with little experience diagnosing and treating pneumoconiosis. This led to a focus on symptomatic treatment rather than addressing the underlying cause of the miners' respiratory problems. Furthermore, overcrowding in public clinics and long wait periods discouraged miners from seeking prompt care, particularly when symptoms were not immediately debilitating.

The data also revealed a large disparity in health-seeking behavior among miners, particularly those in the artisanal sector. Awareness of occupational disorders like pneumoconiosis was generally low, particularly among younger miners and those with limited formal education. The absence of awareness campaigns and preventive health programs in artisanal mining communities contributed to the knowledge gap. As a result, many miners missed the early indicators of pneumoconiosis, mistaking their symptoms for transient illnesses or environmental conditions.

Large-scale miners who had received health and safety training were often more aware of the dangers of dust exposure and the need of detecting pneumoconiosis early on. These miners were more likely to seek medical assistance if they experienced respiratory symptoms and took part in routine health exams provided by their employers. By contrast, artisanal miners were less likely to seek medical attention until their symptoms worsened. According to the data, 50% of artisanal miners waited more than six months after symptoms appeared before seeking medical attention, typically due to a lack of understanding of the progressive nature of pneumoconiosis. Additionally, cultural attitudes and dependence on traditional medicine slowed access to official healthcare for some miners. Many miners reported employing herbal medicines or seeing traditional healers as their first line of therapy, only seeking medical assistance when their condition deteriorated.

National health policy and occupational health rules also have an impact on mine workers' access to and use of healthcare. Zimbabwe's health-care system, which has been pressured by economic issues in recent years, is struggling to satisfy the needs of its citizens, particularly in rural and mining areas. The government's emphasis on primary healthcare services, while crucial, has resulted in gaps in the provision of specialized care for occupational diseases such as pneumoconiosis. Although Zimbabwe has occupational health and safety legislation requiring firms to provide health services to their employees, enforcement of these laws is unequal. Large-scale mining businesses often follow these regulations, including medical coverage and frequent health tests to its employees. However, artisanal and small-scale mining activities, which sometimes operate outside of official regulatory frameworks, do not receive the same level of scrutiny. This regulatory vacuum leaves many artisanal miners without access to the healthcare services required to prevent and manage pneumoconiosis.

Addressing these gaps requires a multimodal approach that improves rural healthcare infrastructure, makes healthcare services more affordable, and raises knowledge about the hazards of pneumoconiosis. Expanding occupational health standards to include artisanal miners, as well as guaranteeing their enforcement, are key steps toward increasing healthcare access for all miners in Mashonaland West. Without such measures, artisanal miners will continue to bear a disproportionate burden of pneumoconiosis and other occupational disorders, resulting in unnecessary suffering and production loss.

5.5 Conclusions

The data analysis reveals a significant rise in pneumoconiosis cases among miners in Mashonaland West, notably in the artisanal mining sector, where inadequate protective measures and prolonged dust exposure are common. Poor ventilation in mines, a lack of dust management, and the limited use of personal protective equipment (PPE) are all significant risk factors. Large-scale miners, while more protected, pose health concerns from extended exposure. Access to healthcare is highly unequal, with artisanal miners facing significant financial and location barriers to medical facilities. This chapter emphasizes the critical need for stronger occupational health policies, more knowledge, and improved healthcare infrastructure to manage the rising burden of pneumoconiosis. Comprehensive interventions concentrating on prevention, early detection, and treatment are critical to protecting miners' health.

5.6 Implications

Prolonged exposure to mineral dust increases the risk of pneumoconiosis. Employing of dust suppression techniques and safety controls in mining environments reduces the risk of repirable dust thereby reducing risk of pneumoconiosis.

5.7 Recommendations

The following are recommendations from the study:

5.7.1 Individual level

- Education, training and awareness among miners to increase their knowledge on mining dusty related and their prevention.
- Adherence of consistnt use of PPE/C

5.7.2 Interpersonal Level

- Awareness on risk perception
- Encourage safety talks on a daily basis among miners

5.7.3 Government/Company level

- To make sure safety regulations are being followed, conduct routine audits and inspections of mining sites. To reduce exposure, this should involve keeping an eye on dust levels and air quality (air quality monitoring).
- Hold frequent training sessions to inform miners about the proper use and significance of personal protective equipment (PPE), with a focus on how PPE can help avoid respiratory ailments.
- Create mobile health clinics or outreach initiatives in mining communities to give miners with convenient respiratory health exams and early detection of pneumoconiosis.
- Maintain centralized health records for miners to ensure easy access and continuity of care, while also allowing healthcare providers to track the evolution of respiratory diseases.
- Encourage collaboration among the government, mining firms, and non-governmental organizations to combine resources and expertise in combating pneumoconiosis and other occupational health hazards.

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APPENDICES

APPENDIX 1: Informed Consent Form for Participants

Analysis of the burden of pneumoconiosis among miners in Mashonaland West from 2017 - 2022.

Consent Form for Study Participants

Principal Investigator : Yvonne Pasipanodya

Phone : +263 776 182 234

Email Address :pasipanodyay@africau.edu

Introduction

You have decided to take part in the research study named above. Your answers will be used to better understand the burden of pneumoconiosis among miners in Mashonaland West. The study will collect your information on demographics and other related information to the study. This consent form gives you information about the collection, storage and future use of data collected from you. You will be asked to sign or make your mark on this form to indicate whether you agree to participate in the study. You will be offered a copy of this form to keep and will keep the other form for at least 3 years. Please ask if you have any questions.

Your participation is voluntary: Participation in the study is voluntary. You may decide to withdraw from the study at any time during the study and this will not affect the services you are getting from your health care provider.

Purpose: The study seeks to analyze the burden of pneumoconiosis among miners in Mashonaland West. The study seeks to To Estimate the Prevalence and Incidence of

Pneumoconiosis Among Miners in Mashonaland West (in selected health facilities), Zimbabwe from 2017 to 2022.

Data collection procedures: Data will be collected using an interviewer-administered questionnaire for the mine workers. Key Informant interviews will be used for key informants with pnuemoconiosis disease.

Data storage: Completed questionnaires will be kept under lock and key for at least 3 years after which they may be destroyed.

Risks and/or Discomforts: There are minimal risks/ discomforts that maybe experienced during this study. There are no ethical risks related to storing your information. Information collected from you will be used only for academic purposes.

Potential Benefits: There are no immediate benefits to you from having your information collected. You and others could benefit from the research findings in future programming.

Confidentiality: To keep your information private, your name will not be written on the questionnaire. I agree to participate in the study

__________________________ ____________ ______________________

Participant Signature or Mark Date Researcher's Signature

Date

If you have any questions concerning this research beyond those answered by the investigator, including questions about the future research, your rights as the source of data; or if you feel that you have been treated unfairly and would like to talk to someone other than a data collector, please feel free to contact …(Academic supervisor) Dr. M.T.S Maibouge on 0780079459/salissoum@africau.edu

APPENDIX 2: Questionnaire
A. Prevalence of Pneumoconiosis

1. **Health and Symptoms:**

- Can you describe any respiratory issues or symptoms you've experienced while working in the mines?
- Have you or anyone you work with ever been diagnosed with pneumoconiosis or any other lung disease?
- When did you first start noticing any symptoms (e.g., coughing, shortness of breath)?
- How do your symptoms affect your daily life and ability to work?

2. **Work History:**

- How long have you been working in the mining industry?
- Can you describe your typical daily tasks in the mine?
- What kind of mining operation do you work in (artisanal, small-scale, large-scale)?

B. Risk Factors Associated with Pneumoconiosis

1. **Exposure to Dust:**

- How much dust are you exposed to on a daily basis while working?
- Are there any specific times or tasks during your work when dust exposure is particularly high?

- Do you believe that the dust you are exposed to is affecting your health? If yes, how?

2. **Safety Measures:**

- Are you provided with any personal protective equipment (PPE), such as face masks or respirators, by your employer?
- How often do you use the PPE provided? Why or why not?
- Is there any training provided on how to reduce dust exposure or use protective equipment properly?

3. **Workplace Environment:**

- What measures are taken at your workplace to control or minimize dust levels?
- How do you feel about the safety of your work environment regarding dust exposure?

4. **General Risk Factors:**

- Apart from dust, are there any other factors in your work environment that you think may increase your risk of lung diseases (e.g., chemicals, smoke)?
- Have there been any incidents in the workplace where safety measures failed, leading to higher dust exposure?

C. Healthcare Access and Utilization

1. **Access to Healthcare:**

- When was the last time you visited a healthcare facility for your respiratory issues or any other health concerns?
- How easy is it for you to access healthcare services in your area, especially for lung-related issues?
- Are there any specific clinics or healthcare providers in your region that specialize in treating miners or respiratory conditions?

2. **Barriers to Healthcare:**

- What challenges do you face when trying to access medical care (e.g., cost, distance, time off work)?
- Are there any financial, logistical, or cultural barriers that prevent you from seeking medical help when you need it?

3. **Quality of Healthcare:**

- How would you describe the quality of care you receive when seeking treatment for respiratory conditions?
- Do you feel that the healthcare workers understand the health risks miners face, particularly in relation to dust exposure?
- Have you received any treatment or medical advice for managing your symptoms or preventing them from worsening?

4. **Healthcare Utilization:**

- Do you regularly go for health check-ups, or only when symptoms become severe?
- How often are miners screened or checked for respiratory conditions like pneumoconiosis in your area?

D. General Well-being and Experiences

1. **Impact on Life:**

- How has working in the mines affected your overall health and well-being?
- Have you noticed any long-term changes in your health since starting mining work?

2. **Community Knowledge and Support:**

- Are you and your fellow miners aware of pneumoconiosis and its causes?
- Do you think there's enough awareness or education about the risks of pneumoconiosis in the mining community?

3. **Suggestions for Improvement:**

- What do you think could be done to improve the safety of miners when it comes to dust exposure?
- What changes would you suggest in terms of healthcare services or workplace practices to better protect your health?

APPENDIX 3: Approval letter from PMD-Mashonaland West Province

Telephone: 067 – 23218
Telegraphic Address:
"PROVMED" Chinhoyi
Fax: 067 - 23218

Email-pmdmashwest@gmail.com

ZIMBABWE

MINISTRY OF HEALTH & CHILD CARE
PROVINCIAL MEDICAL DIRECTOR
(MASHONALAND WEST PROVINCE)
P O BOX 139
CHINHOYI
Zimbabwe

15 October 2024

The DMOs

Re: Request for Permission to Conduct Research in Mashonaland West Province

Yvonne Pasipanodya is a Public Health Student at Africa University. She would like to conduct a research on "Analysis of the burden of Pneumoconiosis Among Miners in Mashonaland West Province from 2017-2022".

The Provincial Medical Director has granted her permission to carry out her research and is upon the approval of the Medical Research Council of Zimbabwe.

MINISTRY OF HEALTH & CHILD CARE
PROVINCIAL MEDICAL DIRECTOR
MASHONALAND WEST PROVINCE
16 OCT 2024
P.O. BOX 139, CHINHOYI
ZIMBABWE TEL: 067-23218

Dr C Dhege
Provincial Medical Director Mashonaland West Province

APPENDIX 4: Clearance Letter from AUREC

AFRICA UNIVERSITY

A United Methodist-Related Institution

"Investing in Africa's future"

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.africau.edu

Ref: AU 3620/25

19 February, 2025

YVONNE PASIPANODYA
C/O Africa University
Box 1320
MUTARE

RE: ***ANALYSIS OF THE BURDEN OF PNEUMOCONIOSIS AMONG MINERS IN MASHONALAND WEST FROM 2017 - 2022.***

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 3620/25
  This number should be used on all correspondences, consent forms, and appropriate document
- **AUREC MEETING DATE** NA
- **APPROVAL DATE** February 19, 2025
- **EXPIRATION DATE** February 19, 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.

AFRICA UNIVERSITY
RESEARCH ETHICS COMMITTEE (AUREC)
APPROVED
P.O. BOX 1320, MUTARE, ZIMBABWE

Yours Faithfully

MARY CHINZOU
FOR CHAIRPERSON
AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE