OCCUPATIONAL HEALTH RISKS AMONGST ARTISANAL AND SMALL-SCALE GOLD MINERS IN BINDURA TOWN, ZIMBABWE

BY

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## DECLARATION

I, MCDONALD TINASHE MATEMERA, student number 11626918 hereby declare that this mini-dissertation titled "**Occupational Health Risks Amongst Artisanal And Small-Scale Gold Miners In Bindura Town, Zimbabwe**" that I have submitted for a Masters of Public Health Degree, in the School of Health Sciences at the University of Venda has not been previously submitted for a degree at this or any other institution, and that it is my own work in design and execution, and that all reference materials herein have been indicated and duly acknowledged.

Signature Date:

09/06/2021

# DEDICATION

I would like to dedicate this work to my mother Patience Mubairatsunga and my late grandmother Raida Chiukuse for the impact they made in my life and the support they gave me throughout my existence. I also dedicate this dissertation to the artisanal gold miners who are struggling to make ends meet under very trying circumstances in Bindura.

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## LIST OF ACRONYMS/ ABBREVIATIONS

| | |
|---|---|
| ASMG | Artisanal and Small-Scale Gold Miners |
| HRA | Health Risk Assessment |
| ICMM | International Council on Mining and Metals |
| MMH | Manual Handling of Materials |
| PPE | Personal Protective Equipment |
| UNEP | United Nations Environment Programme |
| UNICEF | United Nations Children's Fund |
| WHO | World Health Organisation |

# ABSTRACT

Artisanal and small-scale mining is a global mining activity and it is estimated that about 13-20million people in developing countries are artisanal miners who are exposed to numerous health related occupational hazards. Artisanal and small-scale gold mining is mainly done in most remote areas and is a source of livelihoods for the poor in such areas. The purpose of this study was to describe the occupational health risks amongst artisanal and small-scale gold miners in Bindura, Zimbabwe. The researcher conducted a quantitative study, using a cross-sectional survey and descriptive design to gather data from 292 artisanal and small-scale gold miners. The study setting included two artisanal mining sites, located in Bindura, Zimbabwe. Convenience sampling was used to select survey respondents from two mining sites; namely, Ran Mine and Kwa Kitsi Mine. Self-administered questionnaires were used to collect data focusing on respondents' exposure to physical health, chemical agents, psycho-social and mining equipment-related risks. The collected data was captured, coded and analysed using the Statistical Package for Social Sciences (SPSS Version 25.0). Descriptive statistics, frequency tables, graphs, Chi-Squared tests were used to describe trends and patterns in survey data.

Research findings established that small-scale gold miners had inadequate physical space to move around, inappropriate temperature regulations and inappropriate ventilation at their workplaces. Chi-Squared tests for relationship revealed that adequacy of ventilation at workplace was significantly related with mining site (Chi-Square = 52.494, $p < 0.05$). Seventy percent of respondents reported that they sustained work related injuries. Findings show that injuries at work are mainly caused by work related accidents. Most artisanal miners (88%) are exposed to mercury vapour which is hazardous (9 in every 10 artisanal miners are exposed to mercury). All respondents (n = 292; 100%) confirmed that they do not wear personal protective clothing when handling chemicals. The study concludes that artisanal and small-scale gold miners are exposed an array of occupational health risks. Appropriate practice of occupational safety and health should be raised among artisanal miners as well as all individuals responsible for the operations in the mining industry.

**Key words**: Artisanal and Small-Scale gold mining, Occupational Health Risks, Occupational Health and Physical Health Risk.

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## CHAPTER ONE

### 1.1 INTRODUCTION AND BACKGROUND OF THE STUDY

According to Acutt & Hattingh (2016), the workplace and work itself may adversely affect workers' health and this can be attributed to several factors. Occupational health risk is when workplace hazards are involved and workers' exposure to such hazards with a possibility of harm or danger to the exposed.

Artisanal and small-scale gold mining is responsible for a quarter of all gold extracted globally and is often seen as a livelihood alternative for poverty-stricken communities worldwide, and an estimated 150 million people earn their income from Artisanal mining (Tsang, Lockhart, Spiegel, & Yassi 2019). Artisanal mining workers are at high risks for occupational injury, exposure to mercury, as well as cyanide, and development of silicosis and tuberculosis amongst other diseases. Environmental degradation, as a result of extensive excavation, and mercury contamination of agriculture and seafood, lead to further consequences on human health (Tsang *et al.* 2019).

Most Artisanal and small-scale gold miners are utilising primitive tools such as picks, shovels, buckets, and gold pans (Schwartz, Lee, &Darrah 2021). The mining and refining processes are labour intensive and associated with a variety of health problems due to accidents, overheating, overexertion, dust inhalation, exposure to toxic chemicals and gases, violence, and illicit and prescription drug and alcohol addiction (Schwartz *et al*. 2021). In as much as Artisanal and small-scale mining is a high-risk activity, the disadvantages are counterbalanced by the immense economic benefits.

Artisanal and small-scale gold mining process usually involves the dredging of alluvial deposits and the excavation of hard rock containing gold deposits. The rocks are crushed using hammer or mill. The gold is then separated from the other material and mercury is used to amalgamate the gold. This mining is more challenging because miners need to dig mineshafts, work underground, and bring ore-bearing rocks out of the mine for processing. Artisanal miners access these deposits through crude, poorly supported shafts without proper supports and ventilation, (Schwartz *et al.* 2021).

Artisanal and small-scale miners usually target placer deposits containing gold, diamonds, coloured stones, or tin weathered from bedrock. Placer deposits are commonly alluvial sands and gravels rich in precious metals or gemstones. Modern or older settings include overbank flow deposits, riverbank terraces, or in-bank deposits. The basic tool kit for placer mining includes shovels, pans, buckets, and homemade sluice boxes for gold (Schwartz *et al.* 2021).

It is estimated that there are about10 000 artisanal gold miners in Brazil, 100 000-200 000 in Burkina Faso, 18 000 in Ghana, 12 000 000 In India, 60 000 in Mozambique, 10 000 in South Africa and 350 000-500 000 in Zimbabwe (WHO 2016). In as much as artisanal and small-scale gold mining exists in almost every developing country across the globe, it does not operate in the same manner in all countries. The diversity of artisanal gold mining depends on different factors, which include, legality; for instance, in some countries like Brazil and Columbia, artisanal mining is legalised while in many African countries such as Zimbabwe and South Africa it remains an illegal activity (WHO 2016). Artisanal and small-scale mining also differ in terms of its origins. In some countries, artisanal gold mining is practised by migrants, while in other countries artisanal mining is for locals or both, for example; when mining started in South Africa many workers were coming from the neighbouring countries such as Zimbabwe and Mozambique. Artisanal gold mining can also differ in terms of the demographic inclusion, for example, men, women, children, the old aged and their involvement in mining activities vary from country to country (WHO 2016).

In Indonesia, there are more than 800 places where artisanal and small-scale gold mining is practiced, and it is a source of income for more than 2million miners and their communities since it produces above 100 tons of gold per annum. However, artisanal mining in Indonesia is also responsible for 57.5% of mercury emissions in the country which poses serious health risks to the miners and their community (Bose-O'Reilly *et al*. 2016). In Burkina Faso, artisanal and small-scale gold mining (ASGM) is an important economic activity and it is a source of livelihood for many; however, it is related to mercury exposure and other health-related issues (Black, Richard, Rossin & Telmer 2017).

A study conducted in Ghana revealed that a wide range of health and safety issues impact on artisanal miners and their communities (Smith, Ali, Bofinger & Collins 2016). A study conducted in Australia on artisanal gold mining included scholars from University of Queensland and Mongolian mine inspectors as participants; 63% of the respondents pointed to mercury as a health risk, 50% of the respondents mentioned rock falls pit collapses, 13% mentioned, noise, life style factors, limited exits, traumatic injuries, lack of safety culture, training and personal protective equipment as health risks associated with artisanal and small scale gold mining (Smith *et al.* 2016).

Over the years, the Artisanal and small-scale mining sector has not achieved health and safety improvements similar to large scale mines. The risk of accident in Artisanal and small-scale mining is believed to be 7 times higher than that in Large scale mining, and women and children are 90 times at risk of fatality, (Ajith, Ghosh & Jansz 2020). A study carried out in the Democratic Republic of Congo and Ghana, respectively, established that people working in Artisanal and small-scale mining operations are exposed to various hazards with notable serious health implications (Ajith, Ghosh & Jansz 2020).

Mining in Zimbabwe dates back to the 15th century when Zimbabweans were trading with the Portuguese and mined gold in rivers such as Mazowe, Angwa, Odzi and Mutare (Moyo, Chivivi, Mapuwei & Masuku 2015). Artisanal and small-scale gold mining in Zimbabwe is illegal, the illegal gold miners are referred to as *makorokoza*, and others are called *mashurugwi* (The gangs). Artisanal mining in Zimbabwe is considered a poverty driven activity and it is a source of livelihoods for an estimated 400 000 illegal gold miners (Dalu, Wasserman & Dalu 2017). ASGM in Zimbabwe is mainly illegal (approximately 70%) or informal mining (approximately 30%), but around 70% of the miners are unskilled (Becker, O'Reilly, Shoko, Singo & Muschack 2020). According to Dalu, Wasserman, & Dalu (2017), formalization of artisanal gold mining in Zimbabwe will help to establish transparency in gold production and trading in the country. However, it has been proposed that training in mining should be provided to artisanal miners in order to protect the environment as well as protecting the miners from health hazards they face during their mining activities. The artisanal miners are exposed to occupational health risks because to lack of training and risky working environment.

## 1.2 PROBLEM STATEMENT

According to Smith *et al*. (2016), health and safety risk amongst artisanal and small-scale gold miners have not been fully addressed in scholarly literature. Mining activities also contribute to deaths due to injuries, diseases and fatal accidents which may occur during the mining process. However, health and safety issues of artisanal and small-scale miners have not been fully represented by governments and regulatory bodies since these mining activities are mostly illegal. The researcher is a Zimbabwean citizen and is a resident of Bindura town who grew up in the town, thus he once practiced it, and observed that artisanal and small-scale mining is an activity commonly practiced in the area. It is against this background that the researcher finds occupational health risks associated with artisanal mining as a problem that warrants thorough investigation.

## 1.3 RATIONALE FOR THE STUDY

The study is of paramount importance, since little has been done on occupational health risks amongst artisanal gold miners  Although artisanal and small-scale mining activity is an important source of livelihood among the impoverished people in developing nations, the sector has not achieved health and safety improvements (Ajith, Ghosh & Jansz 2020).A comprehensive article by (WHO 2016) suggest that primary health care practitioners could contribute towards resolving some health problems faced by artisanal gold miners Studies on the occupational health risks of ASGM have not been extensively carried out in Zimbabwe. Occupational health risks in ASGM is not only a small community problem, but national and a global problem. Health risks amongst artisanal gold miners has been a challenge for a long time, however, many researchers have mainly focused on chemical hazards and solely on mercury exposure; therefore, there is need for an inquiry into other health risks.

## 1.4 SIGNIFICANCE OF THE STUDY

The research made quantitative data on occupational health risks amongst artisanal and small-scale gold miners in Bindura Zimbabwe. The findings of the study contribute towards the existing body of knowledge, since there is lack of scholarly information on this area of study. Recommendations were made to inform the decision makers on how they can resolve health-related risks associated with artisanal and small-scale miners. Consequently, the study results can be of potential benefit to the state because it gives relevant information to formulate ways to deal with artisanal gold miners' occupational health issues.

## 1.5 AIM OF THE STUDY

The aim of the study was to investigate occupational health risks among artisanal and small-scale gold miners in Bindura, a small town in Zimbabwe.

### 1.5.1. Objectives of the Study

The objectives of the study were to:

- Describe physical health risks associated with artisanal and small-scale gold mining.
- Identify chemical health risks associated with artisanal and small-scale gold mining.
- Assess the psychosocial health risks associated with artisanal and small-scale gold mining.
- Identify mechanical health risks associated with artisanal and small-scale gold mining.

## 1.6 DEFINITION OF CONCEPTS

**Artisanal and small scale mining** refers to mining practised by individuals, groups or communities often informally (illegally) and in developing nations, a common definition for this sector has not been adopted as its legal status, defining criteria, and local definitions vary from country to country (Hentschel, Hruschka, & Priester 2002).

In this study, artisanal and small-scale mining refers to marginalised gold miners who exploit alluvial deposits or dig for gold and have limited access to markets and are exposed to numerous health risks.

**Human Health risk** refers to the degree of likelihood of one or more exposures to hazardous substances that may damage or will damage the health of the exposed person (Business Dictionary 2018). In this study, human health risk refers to exposure to substances or environment that may have an adverse impact on health or well-being of an individual or community.

**Occupational health** refers to the promotion and maintenance of highest degree of physical, mental and social well-being of workers in all occupations through identifying and controlling known or suspected work factors that contribute to ill-health (Waldron 2013).In this study, occupational health refers to the mental, physical and social well-being of the worker and the identification of health risks that may affect their well-being.

**Occupational health risks**

An occupational health risk is defined as a potential harm or threat to a healthy well-being of an individual as a result of exposure to various levels of workplace hazards (WHO 2016). In this study, occupational health risks refer to all work-related conditions that may pose a threat to the physical, mental and social wellbeing of employees.

## 1.7 THEORETICAL FRAMEWORK: HEALTH RISK ASSESSMENT MODEL

The study was guided by the Health Risk Assessment (HRA) model. HRA is a structured and systematic, identification and analysis of workplace hazards. The aim of HRA is to reduce the risk of exposure to hazards through the development and implementation of avoidance, control and control failure recovery measures. In an occupational setting HRA is the preliminary component of health risk management. Health risk management is a decision-making process involving considering political, social, economic and engineering factors collectively with risk assessment information to develop, analyse, compare options and select between them (ICMM 2016).

In this study, the researcher utilised the Baseline HRA, to determine the status of occupational health risks associated with artisanal gold mining. This type of health risk assessment was used because it encompasses all potential exposures, such as physical, chemical, mechanical and psychosocial health risks.

## 1.8 CHAPTER OUTLINE

**Chapter 1:** Introduction and background of the study, problem statement, rationale,

significance, purpose, objectives of the study, theoretical framework, and definition of the concepts.

**Chapter 2**: Literature review which consists of the occupational health risks for artisanal and small-scale miners.

**Chapter 3:** Outline research methods that were used in data gathering, collection presentation and analysis

**Chapter 4:** Presentation of the results

**Chapter 5:** Discussion of results

**Chapter 6:** Summary, Conclusion and Recommendations

## 1.9 CONCLUSION

Chapter one described background of the study, problem statement, rationale for the study, significant of the study, aim of the study, the objectives of the study, chapter outline, definition of terms as well as the theoretical framework. The next chapter provides detailed literature for this study.

# CHAPTER TWO

## LITERATURE REVIEW

### 2.1 INTRODUCTION

This chapter presents literature or previous work by other researchers on occupational health risks amongst artisanal and small-scale gold miners. The literature was mainly extracted from primary and secondary sources of data. Data based and theoretical-based literature on physical health risks, chemical health risks and psychosocial health risks among artisanal and small-scale miners are articulated in this Chapter. Literature was searched from science-direct and other published government reports on Zimbabwe's overall mining sector.

### 2.2 PHYSICAL HEALTH RISKS

Physical health risks associated with artisanal and small-scale gold miners include heavy workloads, long working hours, repetitive tasks and the use of unsafe mining equipment. These activities may cause the development of musculoskeletal disorders, of which, the most common disorders are shoulder disorders, lower back pain and fatigue (WHO, 2016). Physical health risks among artisanal and small-scale gold miners are many, when compared to other categories as they also include vibration, loud noise, heat, humidity and radiation (WHO, 2016).

#### 2.2.1 Musculoskeletal disorders

The prevalence of work-related musculoskeletal disorders (WMSDs) in many industries worldwide, including the large and labour-intensive mining sector has been recently acknowledged (Sen, Sanjog, & Karmakar 2020). Artisanal and small-scale miners may experience shoulder disorders as a result of lifting heavy workloads such as carrying sacks from underground to the surface (WHO 2016). Musculoskeletal disorders are a common form of ergonomic hazards which is closely associated to mining ventures and the risk factors involve awkward body posture, manual material handling, repetitive motions, force and vibration. Sen, Sanjog, & Karmakar (2020), reported that prolonged static body postures, repetitive and jarring movements are significant risk factors for WMSDs.

#### 2.2.2 Overexertion

In 2016, overexertion was reported as one of the health impacts associated with artisanal small-scale mining (ASM) due to the absence of mechanization, long working hours, and extremely hazardous workplaces create biomechanical problems, caused by accidents, lifting, lugging, digging, and falling (WHO 2016). Literature shows that overexertion injuries account for many disabling injuries. The effects of overexertion were reported among the major health risks associated with small-scale mining and processing. In artisanal and small-scale gold mining, overexertion is caused by awkward postures and carrying-out monotonous tasks using non-mechanized tools (Ajith, Ghosh & Jansz 2020). Accidents caused by the repetitive use of sledgehammers, drills, pickaxes and rock crushers are minor when compared to serious injuries caused by power tools and electrical equipment, can result in (WHO, 2016). It is, therefore, important to understand the health impacts of overexertion sprain and strain related injuries to minimize related bad health incomes whenever necessary. This will not only save lives but also sustain the viability of artisanal small-scale mining activities. In this study, the causes of overexertion were studied from manual materials handling (MMH) perspective, (WHO 2016).

### 2.2.3 Physical trauma

Traumatic injuries related to artisanal and small-scale gold miners include burns, eye injuries, fractures, impalement and in some instances, physical dismemberment, (CalysTagoe *et al.,* 2015; Long, Sun & Neitzel, 2015). These injuries are often caused by rockfalls, explosions, inappropriate and unsafe use of mining equipment. The latter can not only cause biomechanical injuries, but can also result in electrical shocks, thermal and electrical burns. In Ghana, Kyeremateng-Amoah & Clarke (2015) reported that injuries sustained by ASGM miners are primarily because of unsafe working conditions and they ranged from minor types such as contusions to severe types such as fractures and spinal cord injuries. The use of explosives can result in exposure to dangerous levels of dust (silicosis), noise and vibration, which leads to asphyxiation and, in some cases death due to acute traumatic injury, (Ralph, Gilles, Fon, Luma & Greg 2018). Fadlallah, Pal & Hoe, (2020). Reported that artisanal miners were persistently exposed to accidents and fatal injuries in a case study conducted in Sudan.

### 2.2.4 Noise

Noise exposure is associated with the following health outcomes: hearing impairment, hypertension, ischemic heart disease, and stress Noise is also associated with sleep disturbances and cognitive impairment as well as social and behavioural effects including annoyance (WHO 2016). Many tasks carried out in ASGM work processes (for example, extraction, crushing and milling) are associated with elevated occupational and community noise levels, which often exceeds WHO guideline limits meant to prevent loss of hearing (Green *et al.,* 2015).

### 2.2.5 Heat and humidity

Heat is part of the World Health Organisation's (WHO) long list of health hazards. The final step in gold processing involves heating the mercury-gold mixture to volatilize the mercury. This creates a highly mobile and toxic vector of mercury exposure, leaving behind a purified form of gold (WHO, 2016). Heating contributes to excessively high temperatures in the workspace coupled with humid conditions which results from the condensation of mercury vapour. This contributes to extremely hot and humid working conditions for small-scale artisanal miners, and problem is further compounded by the labour-intensive nature of ASGM. This exposes small-scale artisanal miners to heat stress and its associated health effects, which include dizziness, faintness, shortness of breath or breathing difficulties, palpitations and excessive thirst (WHO 2016). Heat, humidity and lack of oxygen are the major health risks associated with small-scale mining and processing due to poorly ventilated physical workspace for artisanal miners (Ajith, Ghosh & Jansz 2020). The growing literature in heat stress management emphasize the rising need to design heat control strategies in order to minimize bad health outcomes on small-scale artisanal gold miners.

## 2.2 CHEMICAL HEALTH RISKS

Artisanal miners are susceptible to inhalation, absorption and ingestion of chemicals during the mining process. The most common chemical exposures in ASGM are to mercury (which is used to amalgamate the gold), cyanide (used to extract gold, for example, from tailings); and other chemicals contained in dust and gases (WHO, 2016).

### 2.3.1 Mercury exposure

Mercury (Hg) is poisonous to both humans and the environment. Artisanal and small-scale gold mining (ASGM) is the largest source of mercury (Hg) emissions and releases worldwide (UNEP, 2018). The breakdown of anthropogenic Hg emissions by sectors shows that the predominant source sector is ASGM (about 38%) followed by stationary combustion of coal (about 21%) (UNEP, 2018). Chronic exposure to mercury damages the neurological system causing sensory, motor and cognitive disorders (Ralph, Gilles, Fon, Luma & Greg 2018). People can be exposed to two forms of mercury in an ASGM context: elemental mercury and organic mercury. Elemental mercury is used in the ASGM process to form gold amalgam. The most important direct route of exposure is by inhalation. Highest concentrations of elemental mercury vapours are released when the gold amalgam is heated (WHO, 2016). This heating process may occur on-site, at gold shops or at gold processing centres, many of which are in populated areas. Individuals working in or living near these facilities can, be heavily exposed to elemental mercury vapour in a manner that exceed

World Health Organization's recommended limits (UNEP, 2018). Mercury vapor, when inhaled, could quickly enter the circulatory system via the pulmonary alveolar membranes and invade the CNS, blood cells, and the kidneys where it can be partially converted to $HgCl_2$ and retained for years (Afrifa, Opoku, Gyamerah, Ashiagbor & Sorkpor 2019). Elemental mercury intoxication manifests in neurological, kidney and autoimmune impairment (WHO 2016). Chronic lower level exposure to elemental mercury causes gingivostomatitis, photophobia, tremors and neuropsychiatric symptoms such as fatigue, insomnia, anorexia, shyness, withdrawal, depression, nervousness, irritability and memory problems (WHO, 2016). The groups at risk of methyl mercury intoxication include individuals who consume large amounts of mercury-contaminated fish. ASGM populations who are also fish-eaters are at risk of mercury intoxication of both the elemental and the organic forms (WHO 2016)

### 2.3.2 Cyanide

Due to its high gold recovery rate and low cost, cyanide is increasingly used in ASGM, but often after mercury has already been used, for example, on tailings (wastes). Mercury-cyanide compounds are easily dispersed in water and, therefore, can enhance the mobility and/or bioavailability of mercury in the environment (UNEP 2018). According to cross-sectional epidemiological study carried out in three ASGM sites in Burkina Faso and three groups were included in the study: (1) miners using cyanide; (2) miners who do not use cyanide; and (3) ASGM community members not directly involved in mining, (Knoblauch, Farnham, Ouoba, Zanetti, Müller, Jean-Richard, Utzinger, Wehrli, Brugger, Diagbouga & Winkler 2020). Mean blood lactate levels were significantly higher in miners using cyanide (4.7 mmol/L, 95% confidence interval (CI) 3.8–5.6 mmol/L), compared to non-cyanide using miners (3.4 mmol/L, 95% CI 2.9–3.7 mmol/L) and other community members not involved in mining activities (2.8 mmol/L, 95% CI 2.4–3.2 mmol/L). Multiple linear regression models found loss of short-term memory reported by participants associated with higher blood lactate level. The study concluded that the use of cyanide in Burkina Faso's ASGM sector is associated with potential negative health effects (Knoblauch *et al*. 2020).

While cyanide does not persevere in the environment, improper storage, handling and waste management can have severe human health and environmental effects (UNEP 2018). Cyanide interferes with human respiration at cellular level and can cause severe and acute effects including rapid breathing, tremors, asphyxiation and death. Chronic effects include neuro-pathological lesions, difficulty when breathing, chest pains, nausea, headaches and enlarged thyroid glands, (WHO 2016).

### 2.3.3 Toxic gases

Blasting generates several toxic gases such as sulphur dioxide, nitrogen oxides and carbon monoxide. The use of petrol- or diesel-operated machinery, particularly in confined spaces where adequate ventilation is lacking is also a major factor in carbon monoxide exposure, which can cause lethal poisoning (Agency for Toxic Substances and Disease Registry, 2012). Furthermore, gases such as methane, nitrogen oxides and others that occur naturally in underground mining may displace and reduce oxygen in confined spaces, causing asphyxiation. The suffocation of oxygen caused by accumulation of toxic gases (carbon monoxide, hydrogen sulphide, sulphur dioxides and others) is a common incident (Ralph et al. 2018). The additive or synergistic effects of all these toxic gases that exist within the working environments of small-scale artisanal miners have an important consequence of amplifying individual developmental threats. Bad health outcomes of these toxic gases are mainly caused by poor ventilated mines due to lack of adequate air circulation, (Ralph et al, 2018).

### 2.34 Chemicals contained in the dust

Silica is a mineral found in varying concentrations in ore that is often mined in ASGM processes. Due to their small diameter and crystalline shape, silica dust particles generated during drilling, mineral extraction, ore crushing, and blasting, can be readily inhaled and deposited in the pulmonary tree (airways). Silica dust is toxic to lung tissues and the immune system, causing progressive scarring (even after the exposure has stopped) and increased susceptibility to infectious agents, such as, tuberculosis (Gottesfeld, Andrew & Dalhoff, 2015). The presence of other minerals associated with gold deposits, such as iron arsenic sulphide or lead sulphide can be hazardous. Dust generation during the mining process may make these minerals bio-available to miners and bystanders, (WHO, 2016).

An incident of lead poisoning in Zamfara, Nigeria is a tragic reminder of the fact that, in many instances, artisanal and small-scale miners as well as their family members can be simultaneously exposed to multiple chemical hazards.

## 2.4 PSYCHOSOCIAL HEALTH RISKS

Social, cultural and economic conditions can cause the emergence of psychosocial hazards which manifest in activities such as violence, drug abuse and nutritional deficit.

### 2.4.1 Drug and alcohol abuse

Several studies have cited drug and alcohol abuse as a psychosocial hazard that affects both adult (mostly males) and child miners (Ajith &Ghosh 2019)). The migratory nature of many people who engage in ASGM is believed to contribute to drug and alcohol abuse which is a way to cope with difficult circumstances .Zvarivadza & Nhleko, (2018) reported that artisanal and small-scale miners have a tendency of spending incomes on alcohol abuse and prostitution among male artisanal miners, which expose them to health risks. According to Zvarivadza & Nhleko, (2018) drugs, prostitution, diseases, gambling, alcohol abuse, and degradation of moral standards are frequent consequences of the chaotic occupation at mining sites. In a study conducted by Chipangura, (2019), on the social organisation of the artisanal and small-scale gold miners he found that drug and alcohol abuse was common amongst young miners and was associated with violent behaviour. (An understanding of these forms of psychosocial hazards is important to ensure that the costs associated with artisanal mining are maintained at low levels for the benefits to outweigh the hazards, (Chipangura 2019).

### 2.4.2 Nutritional deficit

Food security is an important motivator of ASGM operations which are frequently poverty driven. Many miners already find it difficult to secure adequate food for their families. Nutritional deficits can be exacerbated in ASGM camps where foodstuffs may be hard to access, for example, due to rising costs of local goods and/or deterioration in quality of agricultural lands (Buxton, 2013). Changes in availability of disposable income in ASGM communities may also have an impact on quality of diets and nutritional status. For example, Long, Renne & Basu, (2015) found that residents of ASGM communities in Ghana reported lower fruit and vegetable consumption but higher sugar and fat consumption than residents of surrounding areas. The latter were reportedly more reliant upon locally grown food items, while the former was thought to consume more packaged foods and food prepared by local vendors (Long, Renne & Basu, 2015).

### 2.4.3 Violence

Alcohol and drug abuse can lead to violence against partners, co-workers and community members. In the Zimbabwean context violence in artisanal mining is sponsored by the elite, (Mkodzongi, 2020). According to Mkodzongi, (2020), in the last quarter of 2019, Zimbabwe experienced a dramatic increase in machete gang violence across Artisanal and Small-Scale Gold Mining (ASGM) areas. The gangs, popularly known as '*Mashurugwi'* which literally refers to people from the small town of Shurugwi in the Midlands Province of Zimbabwe, were reportedly terrorizing mining communities – robbing people of cash, gold and ore.

According to WHO, (2016) many cases of violence amongst artisanal gold miners are not only alcohol related but can also be associated to stressful working conditions, forced child labour and criminal activities such as extortion, theft, sexual violence or intimidation. Where

ASGM operations are regarded as illegal, conflicts can lead to an escalation of violence between miners, authorities and local land users, (WHO 2016).

## 2.5. MECHANICAL HEALTH RISKS

Tools and machines used in mines and mining can cause accidents to workers and the public. Most major mining operations have centres, ranging from medical stations to sophisticated hospitals, to monitor and care for workers' health and safety. These attend to occupational health needs, including care for those injured and ill. Artisanal and Small scale gold miners tend not to have any coverage and may thus be extremely hazardous to the health of their operators and the public at large. In Africa, there are many Artisanal and Small scale mining operations with little or no health and safety regulatory mechanisms. Small-scale mining is expanding rapidly and often uncontrollably in many developing countries, employing large numbers of women and children in dangerous conditions and generating a workplace fatality rate up to 90 times higher than that for mines in industrialized countries (ILO, 2010).

## 2.6. HEALTH RISK ASSESSMENT MODEL

Health risk assessment (HRA) is a process that involves the identification of hazards, examination of potential health effects, measurement of risk exposure and characterisation of the risk (ICMM, 2016). HRA is also defined as a structured, systematic identification and analysis of workplace hazards with the aim of reducing the risk of exposure to those hazards, through the development and implementation of avoidance, control and control failure recovery measures. In occupational settings, it is the preliminary component of health risk management. Health risk management is a decision-making process involving the considerations of political, social, economic and engineering factors combined with risk assessment information to develop, analyse, compare options and to select between them. An HRA can either be quantitative or qualitative.

### Types of HRA

There are three main types of HRA, and they are all conducted at different levels and times. These are baseline HRA, issues-based or target HRA, and continuous HRA. These three types of HRA are discussed below.

**Baseline HRA** is used to determine the current status of occupational health risks associated with a facility and this tends to be a very wide-range assessment encompassing all potential health risk exposures.

An **issues-based assessment** or **target-based HRA** is designed to provide detailed assessment of specific processes, tasks and areas previously identified as priorities in baseline assessment.

**A continuous HRA** is an on-going monitoring programme or a schedule for regular reviews to determine whether conditions have remained the same, whether changes in processes, tasks or other areas have occurred and whether these changes have modified any hazardous exposures and hence, any potential health risk, management of programme changes can also be considered as being part of a continuous HRA programme.

**2.7 CONCLUSION**

The chapter provided a review of the most relevant literature in order to provide in-depth information on the occupational health risks amongst artisanal and small-scale gold miners. The literature reveals that there are some physical health risks associated with artisanal mining and small-scale mining such as musculoskeletal disorders, over-exertion, physical trauma, noise, mercury exposure, psychosocial health risks, just to mention a few. The research design and methods will be described in chapter 3.

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.1 INTRODUCTION

Research is defined as a process that involve the use of advanced, study-specific techniques and processes to help the investigative process of deriving solutions to a given research problem or more specifically fulfilling the objectives of a research study. Literature emphasize the need for researchers to have detailed research plans and anticipate proper research designs to ensure the realization and subsequent reporting of valid and reliable research results (Cooper & Schindler, 2011). Therefore, this Chapter discusses the research methods that were used in this study.

## 3.2 STUDY DESIGN

According to LoBiondo-Wood & Haber, (2017) the broadest category of non-experimental study designs is a survey study and it is further categorized into descriptive, explanatory or comparative surveys. According to Polit & Beck, (2010) the purpose of a descriptive study is to observe, describe and document aspects of a situation as it naturally occurs.

The researcher conducted a quantitative research study using a cross-sectional descriptive survey design. The researcher chose descriptive study because it enabled him to describe occupational health aspects amongst the small-scale artisanal gold miners. The study design was cross-sectional because data was collected at one point in time. Data was collected from small-scale artisanal miners who worked at two mining sites in Bindura (Kwa Kisti and Ran Mine) for a period of one month.

## 3.2 STUDY SETTING

The study was conducted in Bindura a town in Mashonaland Central Province in Zimbabwe. Ran Mine and Kwa Kitsi mine are the two main sites where artisanal and small-scale gold mining takes place in Bindura. Bindura is a mining and farming town and it is the provincial town for Mashonaland Central Province in Zimbabwe, refer to the map below. Bindura town is popular for its rich fertile soils and the presence of minerals such as gold. In 2012 Census, Bindura had a total population of 43 675 of which 21 026 were males, 22 649 were females. Bindura town is located 88km from Zimbabwe’s main capital city, Harare. According to UNICEF, (2015), the average poverty prevalence for Bindura urban was 63.2% and this rate was representative of both rural and urban entities.


Figure 3.1: Map showing position Bindura town

(Source: http://teacher.scholastic.com/activities/globaltrek/destinations/popups/zimbabwe_map.htm)

### 3.3 STUDY POPULATION

In research, population refers to the entire group, which the researcher is interested in and it forms the basis of eligibility criteria (Polit, & Beck, 2010). This population included all artisanal and small-scale gold miners in Bindura. In Bindura, there are two main sites where artisanal and small-scale mining is practiced which are: Ran mine and Kwa Kitsi. Both mining sites have an estimated population of about 2500 small-scale artisanal gold miners.

### 3.4 SAMPLING AND SAMPLING PROCEDURE

Sampling is a process of selecting representative units of a population in a study. Non-probability convenience sampling was adopted for the study. LoBiondo-Wood & Haber, (2017) define non-probability convenience sampling as the use of most readily accessible persons or objects as subjects.

The researcher used a non-probability sampling, where convenience sampling was particularly used. Convenience sampling was selected because gathering all the small-scale artisanal gold miners was an impossible task, therefore, interviewing artisanal gold miners who were at the site on the day and time of data collection was the only feasible way of collecting data from the respondents. Thus, the researcher collected data from all small-scale artisanal gold miners who were present at the mining sites provided their voluntary agreement to participate in the study.

**Inclusion criteria**

To be eligible for inclusion, respondents complied with the following criteria:

- Had at least 6 months of experience as a small-scale artisanal gold miner
- Was at least 18 years and above
- Had consented to participate in the study

**Exclusion criteria**

To be eligible for exclusion, respondents complied with the following criteria:

- Was below the age of 18 years and;
- Did not meet the criteria for the inclusion criteria.

### 3.4.1 Sampling of mining sites

Two main hotspot sites for small-scale artisanal gold mining in Bindura were considered (Ran Mine and Kwa Kitsi Mine).

### 3.4.2 Sample size

Slovin or Yamane formula was used to calculate the sample size, where $N$ is the total number of population, $n$ is the sample size, and $e$ is the level of error and in this study $e$ was to 0.05 (Adam 2020).

$$\mathrm{n} = \frac{\mathrm{N}}{1+\mathrm{N}\,(e)^2}$$

$$\mathrm{n} = 2500/1 + 2500(0.05)^2$$

$$\mathrm{n} = 2500/1 + 2500(0.0025)$$

$$\mathrm{n} = 2500/7.25$$

$$n = 345$$

### 3.4.3 Sampling of artisanal miners

After calculating the sample size, the researcher calculated the proportional sample from the total population of each site using the proposed sample size of 345. The researcher used convenience sampling, meaning that the researcher administered the questionnaire the small-scale artisanal gold miners who were at mining sites on the day and time of data collection. Apart from being onsite at the time of data collection, only respondents who had consented or who met the criteria of inclusion were served with questionnaires. Table 3.1 shows the sampling frame

**Table 3.1: Sampling frame**

| Site | Population | Sample | Percentage |
|---|---|---|---|
| Kwa Kitsi | 1500 | 1500/2500*345= 207 | 60% |
| Ran mine | 1000 | 1000/2500*345= 138 | 40% |
| Total | 2500 | 345 | 100% |

### 3.5 DATA COLLECTION INSTRUMENT

According to Goodman & Moule, (2016), a questionnaire consists of a formalized series of questions and the function of a questionnaire is to provide measures of aspects such as attitudes, behaviors, health status or states such as stress and depression.

In this study, the researcher developed a self-administered questionnaire. The development of the questionnaire was informed by the literature on the research topic under study. The questionnaire was selected as an instrument of choice because it was suitable for the topic which underlined the investigation. The questionnaire was prepared in English before it was translated to local (Shona) language for respondents to easily understand. A language professional from the University of Venda assisted with the translation of the questionnaire.

The questionnaire consisted of five sections which are: (1) demographic variables, (2) physical health risks, (3) chemical health risks (4) psychosocial health risks and (5) mechanical health risks.

### 3.6 VALIDITY AND RELIABILITY

Validity and reliability were ensured as follows in this study.

#### 3.6.1 Validity

Validity refers to whether the instrument is able measure that which it is intended to measure (Creswell, 2017). Two types of validity were considered in this study, which are face validity and content validity. To ensure face validity, the instrument was presented to the Department of Public Health and the Higher Degrees Committee (HDC) of the School of Health Sciences for validation. To ensure content validity in this study, the researcher made sure that the questionnaire was assessed by people with occupational health and safety knowledge. More specifically, the promoters of this research project who are experts in this field played a key role assessing the authenticity of the questions on variables that were studied.

### 3.6.2 Reliability

Reliability speaks to dependability; this means that if the instrument is administered in the same manner in a different setting it should yield the same results (Creswell, 2013). Split-half reliability measures the extent to which all parts of the test equally contribute to what is being measured (Maree, 2016).

In this study, the researcher used the split-half method to assess the internal consistency of the questionnaires. The researcher divided the questionnaire into two halves, thus, forming two separate instruments. The score or results on the two separated "half instruments" were then compared by means of a correlation coefficient. The researcher compared the results of one-half of a test with the results from the other half. The results suggested that the test was reliable. A correlation coefficient value of 0.88 was found which suggested that the instrument was reliable. Correlation values ranges from -1 to 1 where a value -1 (perfect negative correlation), 0 (no relationship) and 1 (perfect positive correlation). In this present study, a correlation of 0.88 translated to a very strong positive correlation between the two "half instruments".

### 3.7 PRE-TEST

A pre-test refers to the testing of a questionnaire on a (statistically) small sample of respondents before a full-scale study (Bryman 2015). In this study, pre-testing was done on a small sample of 10% of the respondents who were then excluded from participating in the actual research. Pre-testing was done to identify any problems related to unclear wording or the questionnaire being too long for it to be administered effectively. Identified unclear areas of the questionnaire were rephrased and/or corrected before the instrument was deployed for data collection. Pre-test also served as a measure of validity and reliability of the data collection tool.

### 3.8 PLAN FOR DATA COLLECTION

The researcher visited the two mining sites in Bindura (Kwa Kitsi and Ran mine), where he asked for permission from the site leaders upon arrival and permission was granted. The researcher then arranged an appropriate time slot to complete the questionnaires with the leader and the miners. After an agreement was reached, a letter that gave them information on the study was read to the artisanal and small-scale gold miners and the researcher issued consent forms. Issues to do with confidentiality and rights of respondents were clarified by the researcher. After the respondents gave their consent, questionnaires were administered. The researcher remained at the site until the respondents completed the questionnaires. respondents who needed assistance were quickly attended to by the researcher. All the respondents were able to write. Data was collected from 100 small-scale miners from Ran Mine and 192 small-scale miners from Kwa Kitsi.

### 3.9 DATA ANALYSIS

According to Burns and Grove, (2011) data analysis is a process that is conducted to reduce, organise and give meaning to the collected data. The data collected for this study was coded, captured and analysed using the Software Package for Social Sciences (SPSS Version 25.0). Statistical methods were used to analyse the data statistically. To be more specific, descriptive statistics, frequency tables, graphs, Chi-Squared tests were used to identify the relationship between variables in the survey data.

### 3.10 ETHICAL CONSIDERATIONS

According to Streubert & Carpenter, (2011) code of ethics has been established for research conduct in response to human rights violations that have occurred in the past. In this study, research ethics were maintained by ensuring practices which prevented form(s) of violation or infringement of respondents' human rights. The ethics considered for the study are briefly discussed below:

#### 3.10.1 Ethical clearance

Researchers obtain approval from the University of Venda's ethical committee. Therefore, ethical clearance project number: SHS/18/PH/37/0402 was obtained from the School of Health Sciences Higher Degrees Committee (SHSHDC) and the University Higher Degrees Committee (UHDC) approved the study. This was after the project had satisfactorily met the requirements for the School of Health Sciences Higher Degrees Committee (SHDC).

#### 3.10.2 Permission to conduct study

Permission to collect data was sought from the leaders of the two mining sites; Kwa Kitsi and Ran mine. Permission was also sought from artisanal and small-scale gold miners from both mining sites.

#### 3.10.3 Informed consent

According to Streubert, & Carpenter, (2011) informed consent means survey respondents have adequate information regarding the research, are capable of comprehending the information, and have the power of free will, which enable them to give a voluntary consent to participate in a research project or decline participation. To ensure that participants' right to informed consent were respected, the researcher used the letter of information (refer to

Appendix A) whose contents were clearly explained before the respondents were asked to sign the consent forms.

### 3.10.4 Confidentiality and Anonymity

According to Polit & Beck, (2010) a promise of confidentiality is a pledge that information given by respondents will not be publicly reported in a manner that identifies them and will not be made accessible to others. In this study, respondents' rights to confidentiality were observed and respected throughout the research process and after its conclusion. Strict anonymity was maintained throughout the study and the findings were reported in a way that made it impossible for one to identify the respondents.

### 3.10.5 Protection from harm

According to Mouton & Babbie, (2001), social research should never injure the people under study whether they volunteer for the study or not. In this study, respondents were protected from harm (physically or emotionally) due to their participation in the study by ensuring that respondents were not asked to perform acts or answer questions that could potentially endanger their lives.

### 3.10.6 Respect for Privacy

According to Welman *et al.,* (2005), respect for privacy is where the respondents are assured of their right to privacy and are informed that their identities will remain anonymous. In this study, Respondents' rights to privacy were observed and respected by ensuring that no respondents' personal information was revealed to anyone without their consent.

## 3.11 CONCLUSION

Chapter three focused on the methodology used in the study. The researcher conducted a quantitative study using a cross-sectional descriptive survey design. The researcher chose descriptive study because it enabled him to describe occupational health aspects amongst small-scale artisanal gold miners. The chapter discussed the techniques that were employed to conduct the research. The population of the study was identified, and the sampling method was clearly explained. The chapter was concluded by explaining the ethical consideration of the study. The results of the study are presented in Chapter 4.

# CHAPTER FOUR

## PRESENTATION OF RESULTS

### 4. INTRODUCTION

The purpose of this Chapter is to present, and report results after carrying out a rigorous analysis of data collected from 292 artisanal miners from two mines located in Bindura, Mashonaland Central Province in Zimbabwe. Descriptive statistics, frequency tables and graphs were used to describe and aid the understanding of artisanal miners' data. Chi-Squared tests of relationship were also employed to gather evidence on the extent to which certain dependent variables were related with the independent variables (socio-demographic and mining related variables). Data analysis was done to investigate the occupational health risks among artisanal and small-scale gold miners in Bindura town of Zimbabwe. More specifically, data analysis was done to fulfil the following objectives:

- To describe the physical health risks associated with artisanal and small-scale gold mining.
- To identify chemical health risks associated with artisanal and small-scale gold mining.
- To assess the psychosocial health risks associated with artisanal and small-scale gold mining.
- To identify mechanical health risks associated with artisanal and small-scale gold mining.

### 4.1 SOCIO-DEMOGRAPHIC AND MINING-RELATED VARIABLES

This part presents the findings with regards to socio-demographic and mining related variables

#### 4.1.1 Gender

Data analysis revealed that of the 292 respondents who participated in this study, 202 (69.2%) were males whilst 90 (30.8%) respondents were females.

#### 4.1.2 Age

Data analysis revealed that of the 292 respondents who took part in the study, 137 (47%) respondents were aged between 26 and 35 years old. Twenty-five percent (n = 73) of the total respondents were aged between 18 to 25 years old, 11% (n = 32) were aged between 36 to 45 years old, 10% (n = 28) were at least 56 years old whilst the remaining 7.5% (n = 22) were aged between 46 and 55 years old. The frequencies show that most of the artisanal gold miners were young people (both young and adult youths).

#### 4.1.3 Marital status

Findings revealed that the majority 225 (77.1%) of respondents were married, 53 (18.2%) were single, and 14 (4.8%) were divorced. Hence, most artisanal gold miners are married (that is, 7 in every 10 artisanal gold miners) and only 2 in every 10 artisanal gold miners are single.

#### 4.1.4 Education

Data analysis revealed that 143 (49%) out of the 292 respondents who participated indicated that they were educated up to secondary level, 83 (28%) had reached primary level, 40 (14%) had no educational qualifications whilst the remaining 26 (9%) revealed that they had reached tertiary level. Therefore, nearly 5 in every 10 artisanal gold miners were educated up to secondary level, 3 in every 10 had reached primary level whilst the remaining 2 in every 10 were equally split between artisanal gold miners who had reached tertiary level and those who had no qualifications.

#### 4.1.5 Mining site

Table 4.1 below shows that that the majority (n = 192; 66.0%) of the respondents were from Kwa Kitsi mine whilst the remaining 100 (34.0%) respondents were from Ran mine. Thus, nearly two-thirds of survey respondents were from Kwa Kitsi mine whilst the remaining one-third were from Ran mine.

#### 4.1.6 Artisanal mining experience

Results from the study revealed that majority of respondents 117 (40%) had more than three years of artisanal mining experience, followed by 72 (25%) respondents who had between 13 months to 2years experience in artisanal mining, then 58 (20%) respondents who had 6 months to one-year experience in artisanal mining and the remainder 45 (15%) respondents had 24months to three years of artisanal mining experience. Hence, 4 in every 10 respondents had more than 37 years of artisanal mining experience, 6 in every 10 respondents were equally shared among those who had 13months to 2years, 6 months to one year and 24months to three years of artisanal mining experience. On average, artisanal miners had mining experience which ranged from 25 and 36 months.

#### 4.1.6 Other professions

Survey respondents were also asked if they possessed other professions apart from being artisanal miners. Data analysis revealed that the majority of respondents 221(76%) reported that they had no other work except artisanal mining, whilst only the remaining 71(24%)

respondents reported that they had other professions. Therefore, nearly 8 in every 10 respondents had no other professions apart from artisanal mining and nearly 2 in every 10 respondents had other professions apart from artisanal gold miners.

### 4.1.7 Role in family

The study revealed that 239 of the 292 respondents involved in the study, (82%) were breadwinners, whilst the remaining 53 (18%) respondents indicated that they were not bread winners. These results show that most respondents were breadwinners (nearly 8 in every 10 artisanal miners) and as previously reported, majority of respondents relied solely on artisanal mining for a living. Two in every 10 respondents reported that they were not breadwinners (this ratio also coincides with the ratio of respondents who are single or not married).

### 4.1.8 Full-time or Part-time artisanal mining

Survey respondents were asked to highlight if they were full-time or part-time artisanal gold miners. Thus, out of the 292 respondents, majority 221(75.7%) respondents indicated that they were full-time artisanal gold miners while the remaining 17(24.3%) respondents are part-time artisanal gold miners. Hence, nearly 8 in every 10 artisanal gold miners are full-time, whilst only 2 in every 10 artisanal gold miners do it on a part-time basis. On average, artisanal gold miners are engaged on full-time basis.

### 4.1.9 Mining status

Respondents were also asked to indicate their mining status (self-employed or laborer). Data analysis revealed that of the 292 respondents, majority 216 (74%) reported that they were self-employed (that is, they owned their mining area) while the remaining 76 (26%) respondents reported that they were laborers (that is, they worked at other people’s mines). Therefore, nearly 7 in every 10 respondents owned the mining area where they performed their artisanal mining activities, whilst 3 in every 10 respondents were laborers. This result means that, on average, respondents owned the mining areas where they carried their artisanal activities (majority respondents were self-employed).

### 4.1.10 Site of work

Data analysis revealed that majority (n = 243; 83%) respondents reported that their mining activities were both underground and above the ground. Thus, 32 (11%) respondents reported that they were only working on the ground, while the remaining 17 (6%) respondents reported that they were only working underground. Hence, nearly 8 in every 10 artisanal gold miners were involved in both surface and underground mining activities. 2 in every 10 artisanal gold miners were equally involved in underground and surface mining. This means that, in general, artisanal miners are involved in both surface and underground mining activities.

**Table 4. 1: Descriptive statistics for Socio-Demographic and Mining-related Variables**

| Variable | Frequencies | | |
|---|---|---|---|
| | Category | F | % |
| Mining site | Kwa Kitsi | 192 | 65.8 |
| | Ran mine | 100 | 34.2 |
| | Total | 292 | 100.0 |
| Age | 18 -25 years | 73 | 25.0 |
| | 26 -35 years | 137 | 46.9 |
| | 36 -45 years | 32 | 11.0 |
| | 46 -55 years | 22 | 7.5 |
| | >=56 years | 28 | 9.6 |
| | Total | 292 | 100.0 |
| Gender | Male | 202 | 69.2 |
| | Female | 90 | 30.8 |
| | Total | 292 | 100.0 |
| Marital status | Single | 53 | 18.2 |
| | Married | 225 | 77.1 |
| | Divorced | 14 | 4.8 |
| | Total | 292 | 100.0 |
| Artisanal mining experience | 6–12 months | 58 | 19.9 |
| | 13–24months | 72 | 24.7 |
| | 25 – 36 months | 45 | 15.4 |
| | >=37months | 117 | 40.1 |
| | Total | 292 | 100.0 |
| Educational level | None | 40 | 13.7 |
| | Primary | 83 | 28.4 |
| | Secondary | 143 | 49.0 |
| | Tertiary | 26 | 8.9 |
| | Total | 292 | 100.0 |
| Other profession | Yes | 71 | 24.3 |
| | No | 221 | 75.7 |
| | Total | 292 | 100.0 |
| Role in family (breadwinner or not) | Yes | 239 | 81.8 |
| | No | 53 | 18.2 |
| | Total | 292 | 100.0 |

| | | | |
|---|---|---|---|
| Full-time or Part-time artisanal mining | full-time | 221 | 75.7 |
| | part-time | 71 | 24.3 |
| | Total | 292 | 100.0 |
| Mining status | self-employed | 216 | 74.0 |
| | Labourer | 76 | 26.0 |
| | Total | 292 | 100.0 |
| Site of work | Underground | 17 | 5.8 |
| | Above ground | 32 | 11.0 |
| | Both | 243 | 83.2 |
| | Total | 292 | 100.0 |

## 4.2 PHYSICAL HEALTH RISKS

The first objective of this study was to describe the physical health risks associated with artisanal and small-scale gold mining. In this section, we present, and report results from a rigorous statistical analysis on all physical health risks related variables. The summary of results is given in figure 1.

### 4.2.1 Adequacy of physical space to move around

Survey respondents were asked to indicate if they had enough physical space to move around in their mining sites. Data revealed that the majority of respondents (93%) had inadequate physical space, 5% had enough physical space, while the remaining 2% were not sure if their physical space was adequate to allow them to move around. Furthermore, data analysis revealed that artisanal miners had insufficient space, which restricted them from moving around while working.

### 4.2.2 Adequacy of working space

Data analysis revealed that the majority of respondents (93%) had inadequate workspace. Hence, 5% had enough workspace, while 2% were not sure if their workspace was enough or not. On average, artisanal gold miners had inadequate workspace.

### 4.2.3 Appropriate temperature regulation

The majority of respondents (92%) did not have appropriate temperature regulations, 5% had appropriate temperature regulations, while the remaining 3% were not sure if they had appropriate temperature regulation at their mining sites. Overall, artisanal gold miners did not have appropriate temperature regulations at their mining sites.

### 4.2.4 Adequate ventilation at workplace

Respondents were also asked if they had adequate ventilation at their workplace and the majority (91%) revealed that ventilation was inadequate at their workplaces, 5% reported that they had adequate ventilation at workplace and the remaining 4% were unsure if they had adequate ventilation at their workplace. Overall, artisanal gold miners had inadequate ventilation at the workplace.

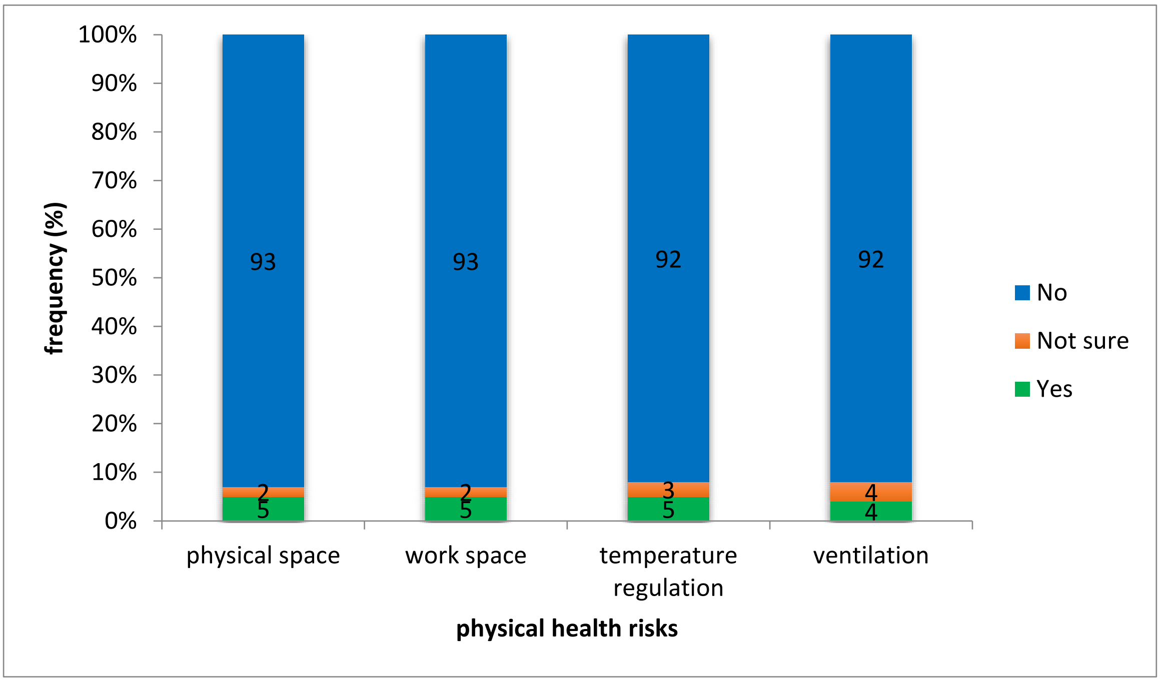



**Figure 1: Distribution of physical health risk -related variables**

### 4.2.5 Chi-Squared Test: Physical Health Risks Versus Respondents' Variables

In this section, we present Chi-Squared test results revealing the level of relationship between physical health risk-related variables and respondents' variables (that is, socio-demographic and mining variables).

#### 4.2.5.1 Adequate Ventilation at workplace

Chi-Squared tests for relationship revealed that adequacy of ventilation at workplace was significantly related with mining site (Chi-Square = 52.494, $p < 0.05$), age (Chi-Square = 18.152, $p < 0.05$), gender (Chi-Square = 7.523, $p < 0.05$), artisanal mining experience (Chi-Square = 39.190, $p < 0.05$), educational level (Chi-Square = 19.156, $p < 0.05$) and site of work (Chi-Square = 222.144, $p < 0.05$) (see table below). Taking mining site as an example, the results indicate that the extent to which ventilation was adequate or inadequate depends on whether respondents were from Kwa Kitsi or Ran Mine. More specifically, the results showed that there was no ventilation at Kwa Kitsi, while Ran Mine had some ventilation in other cases (13% of respondents had ventilation at workplace). These results reveal the extent to which artisanal miners are exposed to risks such as heat, humidity, lack of oxygen and other risks at Kwa Kitsi mine due to poor ventilation.

**Table 4.2.5.1: Chi-Square results of variables significantly related with adequacy of ventilation at workplace**

| Variable | Chi-Square | Degrees of freedom | Sig |
|---|---|---|---|
| Mining site | 52.494 | 2 | < 0.05 |
| Age | 18.152 | 8 | < 0.05 |
| Gender | 7.523 | 2 | < 0.05 |
| artisanal mining experience | 39.190 | 6 | < 0.05 |
| educational level | 19.156 | 6 | < 0.05 |
| site of work | 222.144 | 4 | < 0.05 |

#### 4.2.5.2 Appropriate temperature regulation

Tests for relationship shows the existence of a statistically significant relationship between appropriate temperature regulation and mining site (Chi-Square = 50.21, $p < 0.05$), age (Chi-Square = 15.731, , $p < 0.05$), artisanal mining experience (Chi-Square = 21.405, $p < 0.05$), educational level (Chi-Square = 36.77, $p < 0.05$) and site of work (Chi-Square = 212.46, $p < 0.05$). A statistically significant relationship between temperature regulation and age implies that different age groups are affected differently by availability or non-availability of appropriate temperature regulations at work. Precisely, small-scale artisanal gold miners who are aged between 36 and 45 years unanimously reported non-availability of appropriate temperature regulations at their workplace. On the contrary a small number of respondents who confirmed appropriate temperature regulations at their workplaces are youthful (4.8% of respondents who were <= 35 years old) compared to adult artisanal miners (7.3% of respondents who were >= 45 years old). This indicates that small-scale miners suffer from excessive heat conditions caused by lack of appropriate temperature regulations at workplaces.

#### 4.2.5.3 Enough workspace

Tests for relationship revealed the existence of a statistically significant relationship between enough work space and mining site (Chi-Square = 41.22, $p < 0.05$), artisanal mining experience (Chi-Square = 15.40, $p < 0.05$), educational level (Chi-Square = 13.04, $p < 0.05$) and site of work (Chi-Square = 174.45, $p < 0.05$). A statistically significant relationship between adequacy of workspace and artisanal mining experience implies that the adequacy of workspace at mining sites depends on the respondents' level of mining experience. For instance, artisanal miners whose mining experience was between 13 months and 3 years unanimously reported that workspace was inadequate, whilst some artisanal miners with 6months to 1 year and at least 37 months mining experience reported that workspace was adequate.

#### 4.2.5.4 Enough physical space to move around

Chi-Squared tests for relationship revealed the existence of a statistically significant relationship between availability of physical space for miners to move around and mining site (Chi-Square = 41.22, $p < 0.05$), artisanal mining experience (Chi-Square = 18.63, $p < 0.05$) and site of work (Chi-Square = 174.45, $p < 0.05$). A statistically significant relationship between adequacy of physical space and site of work implies that the extent to which there is enough physical space to move around depends on whether mining activities are carried out underground, on the ground or both. Physical space is adequate for small-scale artisanal miners who mine exclusively on the ground. Conversely, small-scale artisanal miners who practiced underground mining and both (surface and underground) have inadequate space, which restricted them from moving around.

The table 4.2 below present chi-squared test results showing respondents' variables that are significantly related with physical health risk-related variables (ventilation at workplace, appropriate temperature regulation, workspace and physical space).

**Table 4.2: Pearson Chi-Square Tests for Physical Health Risk-related variables (all p-values < 0.05 means a statistically significant relationship)**

| Variables | Is there adequate ventilation at workplace? | | | Do you have appropriate temperature regulation? | | | Do you have enough workspace? | | | Is there enough physical space to move around? | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chi-square | Df | Sig. | Chi-square | Df | Sig. | Chi-square | Df | Sig. | Chi-square | df | Sig. |
| Mining site | 52.494 | 2 | **0.000** | 50.207 | 2 | **0.000** | 41.224 | 2 | **0.000** | 41.224 | 2 | **0.000** |
| Age | 18.152 | 8 | **0.020** | 15.731 | 8 | **0.046** | 8.056 | 8 | 0.428 | 10.035 | 8 | 0.263 |
| Gender | 7.523 | 2 | **0.023** | 2.520 | 2 | 0.284 | 1.027 | 2 | 0.598 | 1.027 | 2 | 0.598 |
| Marital status | 5.896 | 4 | 0.207 | 5.410 | 4 | 0.248 | 4.767 | 4 | 0.312 | 4.118 | 4 | 0.390 |
| Artisanal mining experience | 39.190 | 6 | **0.000** | 21.405 | 6 | **0.002** | 15.402 | 6 | **0.017** | 18.629 | 6 | **0.005** |
| Educational level | 19.156 | 6 | **0.004** | 36.773 | 6 | **0.000** | 13.038 | 6 | **0.042** | 11.698 | 6 | 0.069 |
| Other profession | 2.043 | 2 | 0.360 | 0.944 | 2 | 0.624 | 1.045 | 2 | 0.593 | 0.269 | 2 | 0.874 |
| Role in family (breadwinner or not) | 3.977 | 2 | 0.137 | 3.582 | 2 | 0.167 | 3.285 | 2 | 0.194 | 2.644 | 2 | 0.267 |
| Full-time or part-time artisanal miner | 2.043 | 2 | 0.360 | 0.944 | 2 | 0.624 | 1.045 | 2 | 0.593 | 0.269 | 2 | 0.874 |
| Mining status | 2.399 | 2 | 0.301 | 1.298 | 2 | 0.522 | 1.197 | 2 | 0.550 | 0.455 | 2 | 0.797 |
| Site of work | 222.144 | 4 | **0.000** | 212.463 | 4 | **0.000** | 174.449 | 4 | **0.000** | 174.449 | 4 | **0.000** |

The results presented in table 4.2 shows that all four physical health risk-related variables are significantly related with the two mining sites (Ran Mine or Kwa Kitsi), artisanal mining experience (6-12 months, 13-24 months, 25-36 months or at least 37 months) and site of work (underground, surface or both). In other words, mining site, mining experience and site of work are statistically significant risk factors of physical health-related risks such as heat, lack of oxygen and other risks.

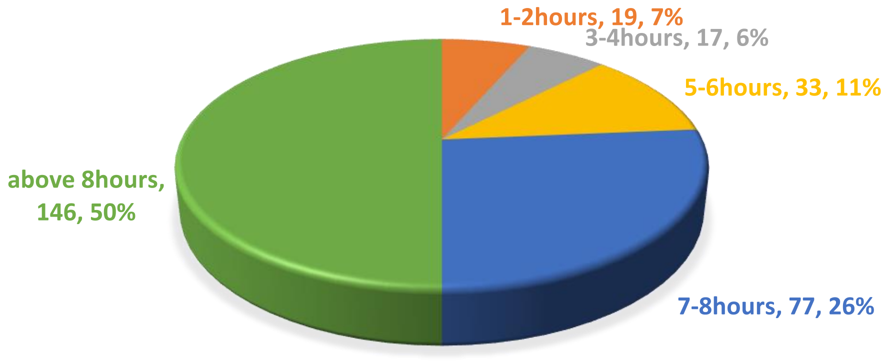
### 4.3 ERGONOMIC ISSUES

This section presents results summarising the number of hours worked by small-scale artisanal miners. The results summarise how heavy manual tasks are carried out in their several kinds by respondents. The section will conclude by presenting Chi-Square test for relationship results, which describe the level of relationship between range of working hours per day and kinds of manual tasks as well as all respondents' related variables such as mining site, age, gender, education level and others.

#### 4.3.1 Number of working hours per day

Figure 4.1 presents the distribution of survey respondents according to their daily working hours. Half of the total respondents (n =146; 50%) reported that they work for more than 8 hours per day, followed by 26% (n = 77) who work between 7-8 hours per day, then by those who work between 5-6 hours per day (n = 33; 11%), 1-2 hours per day (n = 19; 6.5%) and lastly 3-4hours per day (n=17; 6%). Hence, 5 in every 10 artisanal miners work for more than 8 hours per day; nearly 3 in every 10 artisanal miners work for a daily duration ranging between 7-8 hours; whilst nearly 2 in every 10 artisanal miners equally work for 5-6 hours per day and 1-4 hours per day. On average, artisanal miners work for shifts stretching between 7 to 8 hours per day.

Figure 4.1: distribution of the participants' according to working hours



### 4.3.2 Carrying out of heavy manual tasks

Survey respondents were asked to indicate if they carried out heavy manual tasks as small-scale artisanal miners. Data revealed that all respondents (n = 292; 100%) agreed that they carry out heavy tasks manually. Table 4.3 below presents the distribution of respondents by kinds of heavy manual tasks carried out.

**Table 4.3: Distribution of survey respondents by heavy manual tasks**

| Heavy tasks | Frequency | Percentage |
|---|---|---|
| Carrying sacks | 15 | 5.1 |
| Digging | 34 | 11.6 |
| Stone crushing | 49 | 16.8 |
| Carrying water | 16 | 5.5 |
| All heavy manual tasks | 178 | 61.0 |
| Total | 292 | 100.0 |

Table 4.3 shows that majority (n = 178; 61.0%) respondents reported that they perform all heavy manual tasks, followed by those who manually carry crushed stones out of the mine (n = 49; 16.8%), digging (n = 34; 11.6%), carrying water (n =16; 5.5%) and lastly by those who manually carry sacks out of the shaft (n=15; 5.1%). Thus, nearly 12 in every 20 small-scale artisanal miners carry out all heavy tasks manually; 4 in every 20 artisanal miners crush stones manually, 2 in every 20 artisanal digs manually, while nearly 2 in every 20 artisanal miners equally carry water and sacks manually. On average, survey respondents manually fetch water.

### 4.3.3 Standing static for long periods of time

Survey respondents were asked if their artisanal work required them to remain in static positions for longer periods of time. The study revealed that all respondents (n = 292; 100%) reported that their work required them to remain static for longer periods of time. Moreover, respondents were asked to specify the approximate number of hours that best described the durations of time that they work in static positions. Figure 4.2 below show the distribution of survey respondents by hours that they work in static positions.

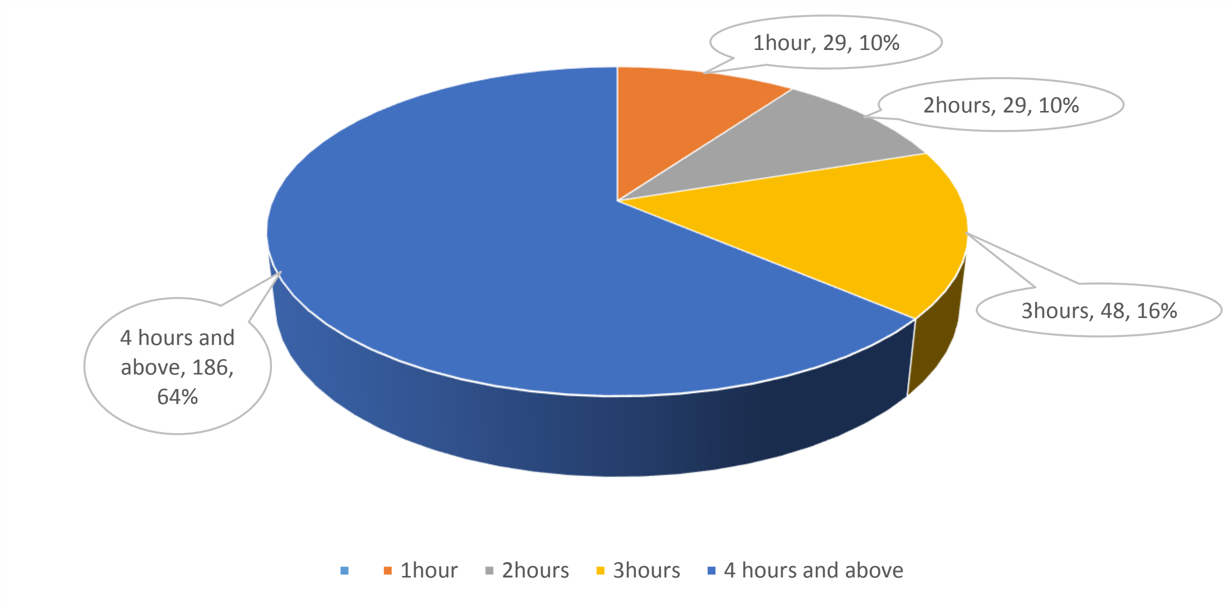



Figure 4.3: Distribution of respondents according to the hours they remain static in one position

Figure 4.2 shows the distribution of respondents according to the number hours that they work in static positions. As clearly shown on the graph, majority (n = 186; 64%) respondents work in static positions for at least 4 hours, 16% (n = 48) of the respondents work in static positions for about 3 hours, while the remaining 20% (n = 58) equally work in static positions for about 1 and 2 hours.

### 4.3.4 Chi-Squared test for relationship

In this section, tests for relationship results describing the relationship between the number of working hours daily, type of heavy tasks, the independent socio-demographic and mining variables are presented. Table 4.4 present the Chi-Square test for relationship results.

#### 4.3.4.1 Daily working hours

Chi-Square tests for relationship revealed the existence of a statistically significant relationship between the range of daily working hours, all socio-demographic information (except for the gender variable) and all mining-related variables as indicated in table 4.4. Taking mining site as an example, these results show that the number of daily working hours for artisanal miners depends on their associated mining site (Ran mine or Kwa Kitsi). More artisanal miners from Ran mine work for a daily range of 1 - 4 hours as well as for more than 8 hours per day when compared to Kwa Kitsi mine. On the other hand, there are more artisanal miners from Kwa Kitsi mine who work for 5-8 hours compared to those at Ran Mine.

#### 4.3.4.2 Types of heavy tasks

Chi-Squared test for relationship established that there is a statistically significant relationship between the type of heavy tasks and mining site, age, marital status, educational level, role in family (breadwinner or not), mining status as well as site of work (see table 4.4). Taking the role of an artisanal miner in the family (breadwinner or not). Thus, the study showed that the relationship between types of heavy tasks and role of artisanal miner in the family implies that heavy manual tasks carried by small-scale artisanal gold miners depend on whether artisanal miners involved are breadwinners or not. Results show that artisanal miners who are breadwinners are more likely to carry all heavy manual tasks compared to those who are not breadwinners. On the contrary, the results established that non-breadwinners are more likely to engage themselves in less heavy tasks such as stone crushing, digging, carrying sacks and water compared to breadwinner artisanal miners. Therefore, small-scale miners who are breadwinners are highly exposed to all forms of risks mainly associated with manually carrying out heavy tasks compared to their counterparts who are non-breadwinners. As a result, strategies to reduce exposure of small-scale artisanal miners to these risks should target both present and potential small-scale artisanal gold miners who are breadwinners.

#### 4.3.4.3 Number of static hours while working

Tests for relationship revealed that a statistically significant relationship exist between the number of static hours spent by artisanal miners at work, mining site, age, gender, marital status, artisanal mining experience and site of work. Taking gender as a variable of reference, a statistically significant relationship between the number of static hours and gender means that the number of hours that artisanal miners spend while standing static in one position depends on whether the miner is male or female. The results show that more male artisanal miners spent time standing static in one position compared to their female counterparts. Precisely, the amount of male artisanal miners who stand static in one position while working increase with an increase in number of hours spent while standing static (positive correlation). On the other hand, a negative relationship reported between the number of female artisanal miners and the number of hours they spent standing static in one position (number of female artisanal miners decreases with an increase in the number of hours spent standing static while working). These results show that male artisanal miners are more exposed to physical and mental health risks associated with lengthy hours that artisanal miners spend standing static while working. Hence, intervention strategies for reducing the risks associated with standing static for long hours should focus more at educating males than females, for example, awareness programs on the dangers associated with standing static for longer periods of time.

#### 4.3.4.4 Personal Protective Equipment (PPE)

Chi-Squared tests for relationship revealed the existence of a statistically significant relationship between the number of static hours while working and mining site, age, gender, marital status, artisanal mining experience as well as educational level. When taking marital status as a reference variable, a statistically significant relationship between wearing of personal protective equipment (PPE) and marital status means that artisanal gold miners' decision to wear or not-to-wear personal protective clothing depends on artisanal miners marital status. Consequently, the results show that married artisanal gold miners do not wear personal protective clothing and that a higher proportion of artisanal miners who are single wear personal protective clothing more than artisanal miners who are divorced.

For detailed results on variables that were found to significantly influence the daily working hours, types of heavy tasks, number of static hours while working and wearing or not wearing personal protective equipment variables, refer to the table 4.4 below.

**Table 4.4: Pearson Chi-Square Tests for Ergonomic issues-related variables (all p-values < 0.05 means a statistically significant relationship)**

| Variable | Range of daily working hours | | | Types of heavy tasks | | | Number of static hours while working | | | Protective clothing | | | Type of protective clothing | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chi-square | Df | Sig. | Chi-square | Df | Sig. | Chi-square | Df | Sig. | Chi-square | Df | Sig. | Chi-square | df | Sig. |
| mining site | 11.072 | 4 | **0.026** | 36.187 | 4 | **0.000** | 15.174 | 3 | **0.002** | 9.402 | 1 | **0.002** | . | . | . |
| Age | 44.138 | 16 | **0.000** | 46.086 | 16 | **0.000** | 47.790 | 12 | **0.000** | 92.778 | 4 | **0.000** | 0.486 | 1 | 0.486 |
| Gender | 2.075 | 4 | 0.722 | 5.144 | 4 | 0.273 | 10.523 | 3 | **0.015** | 13.388 | 1 | **0.000** | 2.082 | 1 | 0.149 |
| Marital status | 33.747 | 8 | **0.000** | 21.449 | 8 | **0.006** | 24.607 | 6 | **0.000** | 70.486 | 2 | **0.000** | 1.431 | 1 | 0.232 |
| Artisanal mining experience | 36.200 | 12 | **0.000** | 20.207 | 12 | 0.063 | 18.220 | 9 | **0.033** | 26.999 | 3 | **0.000** | . | . | . |
| Educational level | 27.178 | 12 | **0.007** | 46.658 | 12 | **0.000** | 5.565 | 9 | 0.783 | 26.166 | 3 | **0.000** | 0.275 | 1 | 0.600 |
| Other profession | 11.586 | 4 | **0.021** | 4.544 | 4 | 0.337 | 4.168 | 3 | 0.244 | .436 | 1 | 0.509 | 0.275 | 1 | 0.600 |
| Role in family (breadwinner or not) | 23.316 | 4 | **0.000** | 22.345 | 4 | **0.000** | 3.334 | 3 | 0.343 | 20.100 | 1 | **0.000** | 2.837 | 1 | 0.092 |
| full-time or part-time artisanal miners | 11.586 | 4 | **0.021** | 5.793 | 4 | 0.215 | 2.533 | 3 | 0.469 | .436 | 1 | 0.509 | 0.275 | 1 | 0.600 |
| Mining status | 14.390 | 4 | **0.006** | 9.792 | 4 | **0.044** | 5.009 | 3 | 0.171 | .658 | 1 | 0.417 | 0.275 | 1 | 0.600 |
| Site of work | 30.938 | 8 | **0.000** | 49.771 | 8 | **0.000** | 69.118 | 6 | **0.000** | 3.640 | 2 | 0.162 | . | . | . |

## 4.4 INCIDENCES OCCUPATIONAL HEALTH PROBLEMS

This section provides statistical results describing variables related to incidences of occupational health problems. The statistical results describe respondents' history and causes of injuries at work.

### 4.4.1 History and causes of injury at work

Table 4.5 gives a summary of frequencies, for history of injury at work in the past 6 months and cause of injury variables. Findings showed that majority of respondents 71% (n = 208) reported that they sustained injuries at work at some point in time during the previous six months dating back from the day and time of data collection. Only 29% (n = 84) of the total respondents did not sustain any injuries during the previous six months stretching back from the day and date of data collection.  On average, respondents were at some point injured at work within the last 6 months dating back from data collection day.

On the other hand, the study showed that majority of respondents 76% (n = 159) reported that work related accidents is one of the major cause of injuries at work, followed by police dogs as reported by approximately 14% (n = 28) (that is, respondents indicated that they were seriously wounded by police dogs during police raids) and lastly, by falling which was reported by nearly 10% (n = 21) of the total respondents. On average, work accidents constitute one of the main causes of injuries at work for small-scale artisanal gold miners.

**Table 4.5: History and causes of injury at work**

| Variables | Response | F | % |
|---|---|---|---|
| History of injury at work in the past 6 months | Yes | 208 | 71.2 |
| | No | 84 | 28.8 |
| | Total | 292 | 100.0 |
| Causes of injury | Falling | 21 | 10.1 |
| | police dogs | 28 | 13.5 |
| | work accident | 159 | 76.4 |
| | Total | 208 | 100.0 |

#### 4.4.1.1 Chi-Squared Test for Relationship

Chi-Squared test results describe the level of relationship between history of injury, causes of injury, several socio-demographic and mining-related variables. As clearly shown in table 4.6 below, there is a statistically significant relationship between the causes of injury and age (Chi-square = 26.47, $p < 0.05$), artisanal mining experience (Chi-Square = 34.30, $p < 0.05$), other profession (Chi-Square = 6.57, $p < 0.05$), full-time or part-time artisanal miner (Chi-square = 6.57, $p < 0.05$), mining status (Chi-Square = 7.52, $p < 0.05$) and site of work (Chi-Square = 11.05, $p < 0.05$). Tests of relationship established the existence of a statistically significant relationship between the causes of injuries and age, which implies that small-scale artisanal miners' injuries at work are influenced by miners age. For instance, positive relationship clearly exists between the causes of injury at work and age groups 26-35 years, 46 -55 years, 56 years and above (that is, the proportion of artisanal miners increases with an increase in nominal coding of the age variable and vice versa). On the other hand, results revealed that small-scale artisanal miners who are at most 45 years old are more prevalent to falling compared to those who are at least 46 years old. In addition, respondents who are 26 - 35 years and those who are at least 56 years old are more prevalent to getting injured by dogs during police raids. Artisanal miners who are within 18 - 25 years, 36 - 45 years and 46 - 55 years are more prone to getting injured through work accidents compared to 26 -35 years age group.

Further, chi-square tests showed the existence of a statistically significant relationship between the causes of injuries and artisanal mining experience (Chi-Square = 34.303, df = 6, $p < 0.05$). The results in table 4.6 below shows that a high proportion of small-scale artisanal gold miners who sustained injuries from police dogs constitutes the respondents with mining experience spanning from 37 months and above (23.6%), followed by 13 months - 2 years (6.8%), 25months - 3years (3.0%) and 6months -1year (2.9%). Therefore, the higher the experience, the higher the proportions of small-scale artisanal miners who sustained injuries from police dogs. On the other hand, the higher the experience the higher the proportions of respondents who were injured at work through falling. For respondents who sustain injuries from work accidents, a clearly negative relationship was shown between proportion of miners who get injured and the level of artisanal experience. Thus, the proportions of injured artisanal miners decrease with an increase in artisanal mining experience. In particular, the proportions of artisanal miners who sustained injuries are as follows; 6 months – 1 year (97.1%), 13 months - 2 years (90.2%), 25 months - 3 years (78.8%) and 37 months and above (56.6%). This shows that many respondents who are less experienced in artisanal mining are more susceptible to sustaining injuries at work. For detailed results presenting summary statistics for all socio-demographic variables significantly related with the history and causes of injuries, please refer to table 4.6 and 4.7 below.

**Table 4.6: Cross-tabulation results for history and cause of the injury versus socio-demographic and mining-related variables**

| Variable | Category | History of injury at work in the past 6 months | | Cause of the injury | | |
|---|---|---|---|---|---|---|
| | | Yes | No | falling | police dogs | work accident |
| Age | 18 -25 years | 68.5% | 31.5% | 6.0% | 2.0% | 92.0% |
| | 26 -35 years | 75.2% | 24.8% | 16.5% | 21.4% | 62.1% |
| | 36 -45 years | 78.1% | 21.9% | 4.0% | 4.0% | 92.0% |
| | 46 -55 years | 59.1% | 40.9% | 0.0% | 7.7% | 92.3% |
| | >=56 years | 60.7% | 39.3% | 0.0% | 17.6% | 82.4% |
| Artisanal mining experience | 6months –1year | 60.3% | 39.7% | 0.0% | 2.9% | 97.1% |
| | 13months – 2years | 70.8% | 29.2% | 0.0% | 9.8% | 90.2% |
| | 25months – 3years | 73.3% | 26.7% | 18.2% | 3.0% | 78.8% |
| | >=37months | 76.1% | 23.9% | 16.9% | 23.6% | 59.6% |
| Other profession | Yes | 74.6% | 25.4% | 18.9% | 15.1% | 66.0% |
| | No | 70.1% | 29.9% | 7.1% | 12.9% | 80.0% |
| Full-time or part-time artisanal miner | full-time | 70.1% | 29.9% | 7.1% | 12.9% | 80.0% |
| | part-time | 74.6% | 25.4% | 18.9% | 15.1% | 66.0% |
| Mining status | Self-employed | 72.7% | 27.3% | 7.0% | 12.7% | 80.3% |
| | Labourer | 67.1% | 32.9% | 19.6% | 15.7% | 64.7% |

| | | | | | | |
|---|---|---|---|---|---|---|
| Site of work | Underground | 58.8% | 41.2% | 0.0% | 0.0% | 100.0% |
| | Above ground | 56.3% | 43.8% | 0.0% | 33.3% | 66.7% |
| | Both | 74.1% | 25.9% | 11.7% | 12.2% | 76.1% |

**Table 4.7: Pearson Chi-Square Tests describing the level of relationship between history and cause of the injury versus socio-demographic and mining-related variables (p-values < 0.05 means a statistically significant relationship)**

| Variable | History of injuries at work in the past 6 months | | | Causes of injury | | |
|---|---|---|---|---|---|---|
| | Chi-square | Df | Sig. | Chi-square | Df | Sig. |
| Mining site | 0.776 | 1 | 0.378 | 2.238 | 2 | 0.327 |
| Age | 5.147 | 4 | 0.273 | 26.465 | 8 | **0.001** |
| Gender | 0.062 | 1 | 0.803 | 2.924 | 2 | 0.232 |
| Marital status | 0.859 | 2 | 0.651 | 3.573 | 4 | 0.467 |
| Artisanal mining experience | 4.793 | 3 | 0.188 | 34.303 | 6 | **0.000** |
| Educational level | 7.044 | 3 | 0.071 | 6.361 | 6 | 0.384 |
| Other profession | 0.534 | 1 | 0.465 | 6.568 | 2 | **0.037** |
| Role in the family (breadwinner or not) | 0.346 | 1 | 0.556 | 3.021 | 2 | 0.221 |
| Full-time or part-time artisanal miner | 0.534 | 1 | 0.465 | 6.568 | 2 | **0.037** |
| Mining status | 0.854 | 1 | 0.355 | 7.521 | 2 | **0.023** |
| Site of work | 5.740 | 2 | 0.057 | 11.052 | 4 | **0.026** |

### 4.4.2 Pain or Discomfort and its effects on artisanal miners

This section presents descriptive statistics summarising responses on pain or discomfort caused by injuries sustained at work by small-scale artisanal gold miners and their effects.

**Table 4.8: Distribution of participant's pain according to body parts**

| Variables | Response | f | % |
|---|---|---|---|
| In the last year, have you had pain or discomfort caused by your job that lasted 2 days or more? | Neck | 4 | 1.4 |
| | Shoulder | 18 | 6.2 |
| | Wrist | 84 | 28.8 |
| | upper back | 11 | 3.8 |
| | lower back | 175 | 59.9 |
| | Total | 292 | 100.0 |

Results in table 4.8 above shows that the majority of respondents 60 % (n = 175) feel pain on their lower back, followed by 29% (n = 84) who feel pain on their wrists, then 6% (n = 18) who feel pain or discomfort on their shoulders, 4% (n = 11) feel pain on their upper backs while 1% (n = 4) feel pain and discomfort on their necks. On average, data analysis showed that respondents feel pain on their upper back .

#### 4.4.2.1 Chi-Squared tests for relationship

Table 4.9 and 4.10 jointly summarise the results for the Chi-Square tests of relationship between pain or discomfort experienced on different body parts and several socio-demographic and mining-related variables. Table 4.9 below shows the existence of a statistically significant relationship between pain or discomfort (dependent variable) and the independent variables such as mining site, age, gender, marital status, artisanal mining experience, educational level, other profession, role of artisanal miners in the family (breadwinner or not), full-time or part-time artisanal miner, mining status and site of work.

Data shows that female artisanal miners endure more pain or discomfort on their necks (75%) and shoulders (66.7%) due to their jobs which is relative to male artisanal miners (necks - 25%; shoulders - 33.3%). Female artisanal miners are 3 and 2 times more likely to experience pain or discomfort on their necks and shoulders respectively due to artisanal mining work than male artisanal miners. On the other hand, male artisanal miners experienced more pain or discomfort on wrist (59.5%), upper back (90.9%) and lower back (77.1%) due to their jobs, which is relative to their female artisanal miners (wrist - 40.5%; upper back – 9.1% and lower back - 22.9%). Male artisanal miners are 1.5, 10 and 3 times more likely to experience pain or discomfort on their wrist, upper back and lower back respectively due to artisanal mining work than female artisanal miners. These results are important towards improving health and safety practitioners' knowledge and understanding of pain or discomfort as experienced by different body parts for the two gender groups.

The study established that full-time artisanal miners experience more pain or discomfort on their shoulders, wrists, upper back and lower back due to their jobs, but it is relative to part-time artisanal miners. The results show the level of pain or discomfort experienced on the neck was the same for both full-time and/or part-time artisanal miners. Artisanal miners who are married experience more pain or discomfort due to their jobs, which is relative to artisanal miners who are either single or divorced. In addition, artisanal miners who are self-employed are more likely to experience pain or discomfort, relative to small-scale artisanal miners who are labourers. The results are suggestive of the possibility that labourers are less likely to expose themselves to risk operational behaviours by virtue of being labourers (low appetite for risk when one is working for someone else). On the contrary, small-scale miners who are self-employed appeared to have a high appetite of risk as their actions tend to be largely guided by winner-take-it-all or no-risk-no-return attitude. For detailed Chi-Squared results for all variables that were found to be significantly associated with pain or discomfort caused by their job that lasted 2 days or more, refer to table 4.10.

**Table 4.9: Cross-tabulation results for pain according to body parts versus socio-demographic and mining-related variables**

| Variables | Category | In the last year, have you had pain or discomfort caused by your job that lasted 2 days or more? | | | | |
|---|---|---|---|---|---|---|
| | | neck | shoulder | wrist | upper back | lower back |
| Mining site | Kwa Kitsi | 75.0% | 100.0% | 84.5% | 0.0% | 57.1% |
| | Ran mine | 25.0% | 0.0% | 15.5% | 100.0% | 42.9% |
| Age | 18 -25 years | 100.0% | 38.9% | 1.2% | 36.4% | 32.6% |
| | 26 -35 years | 0.0% | 0.0% | 78.6% | 18.2% | 39.4% |
| | 36 -45 years | 0.0% | 61.1% | 1.2% | 45.5% | 8.6% |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 46 -55 years | 0.0% | 0.0% | 11.9% | 0.0% | 6.9% |
| | >= 56 years | 0.0% | 0.0% | 7.1% | 0.0% | 12.6% |
| Gender | Male | 25.0% | 33.3% | 59.5% | 90.9% | 77.1% |
| | Female | 75.0% | 66.7% | 40.5% | 9.1% | 22.9% |
| Marital status | Single | 0.0% | 44.4% | 13.1% | 0.0% | 19.4% |
| | Married | 100.0% | 55.6% | 79.8% | 100.0% | 76.0% |
| | Divorced | 0.0% | 0.0% | 7.1% | 0.0% | 4.6% |
| Artisanal mining experience | 6months – 1year | 100.0% | 16.7% | 29.8% | 0.0% | 14.9% |
| | 13 – 24 months | 0.0% | 0.0% | 31.0% | 54.5% | 22.9% |
| | 25 – 36 months | 0.0% | 0.0% | 6.0% | 45.5% | 20.0% |
| | >= 37months | 0.0% | 83.3% | 33.3% | 0.0% | 42.3% |
| Educational level | None | 0.0% | 0.0% | 16.7% | 36.4% | 12.6% |
| | Primary | 0.0% | 66.7% | 36.9% | 36.4% | 20.6% |
| | Secondary | 100.0% | 33.3% | 42.9% | 18.2% | 54.3% |
| | Tertiary | 0.0% | 0.0% | 3.6% | 9.1% | 12.6% |
| Other profession | Yes | 50.0% | 16.7% | 9.5% | 27.3% | 31.4% |
| | No | 50.0% | 83.3% | 90.5% | 72.7% | 68.6% |
| Role in the family (breadwinner or not) | Yes | 100.0% | 61.1% | 86.9% | 100.0% | 80.0% |
| | No | 0.0% | 38.9% | 13.1% | 0.0% | 20.0% |
| Full-time or part-time artisanal miner | full-time | 50.0% | 83.3% | 90.5% | 72.7% | 68.6% |
| | part-time | 50.0% | 16.7% | 9.5% | 27.3% | 31.4% |
| Mining status | self-employed | 50.0% | 83.3% | 90.5% | 72.7% | 65.7% |
| | Labourer | 50.0% | 16.7% | 9.5% | 27.3% | 34.3% |
| Site of work | Underground | 0.0% | 0.0% | 0.0% | 0.0% | 9.7% |

| | | | | | | |
|---|---|---|---|---|---|---|
| | above ground | 0.0% | 0.0% | 15.5% | 0.0% | 10.9% |
| | Both | 100.0% | 100.0% | 84.5% | 100.0% | 79.4% |

**Table 4.10: Pearson Chi-Square Tests for pain according to body parts versus socio-demographic and mining-related variables**

| Variables | In the last year, have you had pain or discomfort caused by your job that lasted 2 days or more? | | |
|---|---|---|---|
| | Chi-square | Df | Sig. |
| Mining site | 49.552 | 4 | 0.000 |
| Age | 138.260 | 16 | 0.000 |
| Gender | 25.823 | 4 | 0.000 |
| Marital status | 15.695 | 8 | 0.047 |
| Artisanal mining experience | 65.237 | 12 | 0.000 |
| Educational level | 38.496 | 12 | 0.000 |
| Other profession | 16.857 | 4 | 0.002 |
| Role in the family (breadwinner or not) | 10.385 | 4 | 0.034 |
| Full-time or part-time artisanal miner | 16.857 | 4 | 0.002 |
| Mining status | 20.104 | 4 | 0.000 |
| Site of work | 17.984 | 8 | 0.021 |

#### 4.4.2.2 Pain or Discomfort while working, after work and after a week away from work

Small-scale artisanal miners were also asked about their experiences with pain or discomfort when working, after working and after a week away from work. Frequency distributions which summarize respondents' responses are presented.

**Pain while working**

The results in table 4.11 shows that majority of respondents' 85% (n = 249) pain worsened when working, whilst the pain for the remaining 15% (n = 43) remained the same while working. This means that the pain of nearly 9 in every 10 respondents worsens when they are at work, while pain of 1 in every 10 small-scale artisanal miners remains the same when working. On average, worst levels of pain are endured by small-scale and artisanal gold miners when working.

**Table 4.11: Participant's state of pain while working**

| Response | Number | Percent% |
|---|---|---|
| The same | 43 | 15 |
| Worse | 249 | 85 |
| Total | 292 | 100 |

**Pain after working**

The results in table 4.12 shows that majority of respondents' 71% (n = 207) level of pain remained the same after working, while the remaining 29% (n = 85) felt less pain after working. Thus, nearly 7 in every 10 respondents' pain remain the same after working, and the remaining 3 in every 10 respondents felt less pain after work. On average, pain endured by small-scale artisanal miners remain the same after working.

**Table 4.12: Participant's state of pain after working**

| Response | Number | Percent% |
|---|---|---|
| Less | 85 | 29 |
| Same | 207 | 71 |
| Total | 292 | 100 |

**Pain after a week away from work**

Data analysis revealed that all respondents (292; 100%) felt less pain after spending a week away from work (see table 4.12).

**Table 4.13: Participant's state of pain after spending a week away from work**

| Response | Number | Percent% |
|---|---|---|
| Less | 292 | 100 |

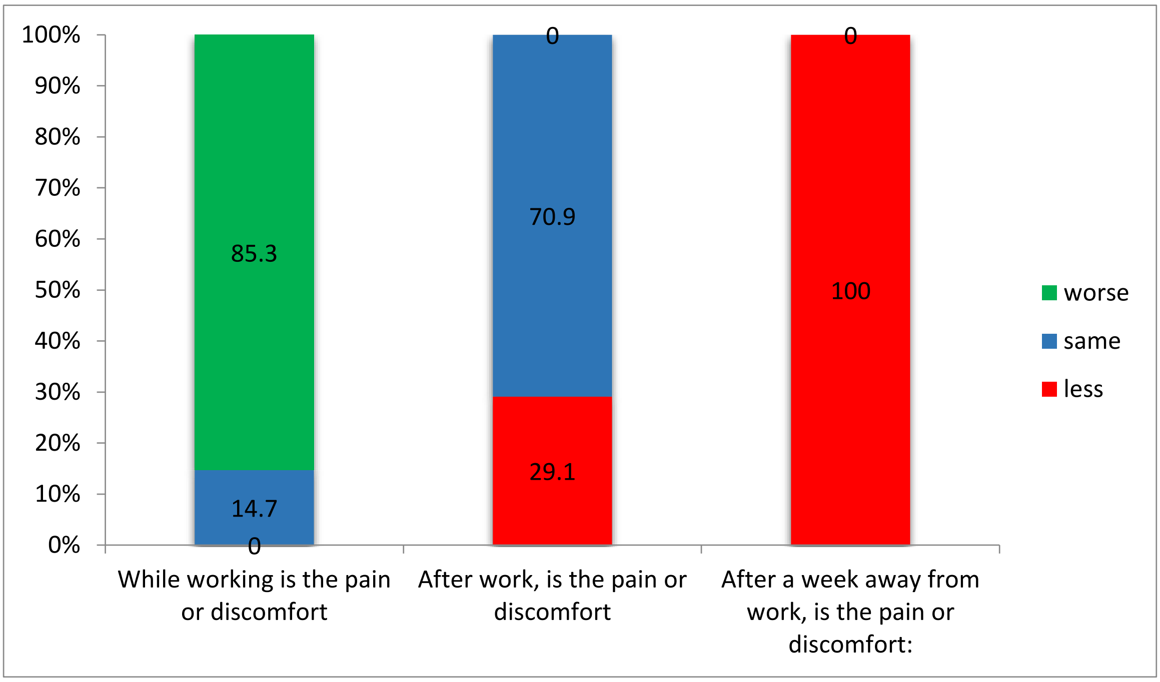



Figure 4. 4: Comparing levels of pain or discomfort for 3 different situations

**Comparing levels of pain or discomfort**

Figure 4.3 present a side-by-side comparison of frequency of responses on the levels of pain or discomfort endured by artisanal miners while working, after work and after spending a week away from work.

The results presented in figure 4.3 above shows that all respondents (n = 292; 100%) felt less pain or discomfort after spending a week away from work, while 29.1% (n = 85) of respondents felt less pain or discomfort after work. 71% (n = 207) and 14.7% (n = 43) of respondents felt the same pain or discomfort after work and while working respectively. In addition, 85% (n = 249) of the total respondents' pain or discomfort become worse when they are working.

### Chi-Squared test for relationship

Table 4.14 and 4.15 jointly present Chi-Squared test of relationship results between the state of pain while working and state of pain after working and the socio-demographic and mining variables. The results show statistically significant relationships between the state of pain while working, mining site, age, marital status and site of work (See table 4.14below). A statistically significant relationship between state of pain while working and mining site, means that the pain or discomfort experienced by artisanal miners while working depends on location or area; whether an artisanal miner is from Ran mine or Kwa Kitsi. Artisanal miners from Ran mine (100.0%) experienced worst levels of pain while working, which is relative to small-scale artisanal miners from Kwa Kitsi (77.6%). In Kwa Kitsi, 22% of the respondents revealed that their pain remained the same while working. These results inform the planning, design and implementation of pain relief programs aimed at managing and easing levels of pain endured by artisanal miners. For a complete list of variables whose relationship with pain or discomfort while and after work were statistically significant, refer to table 4.15.

**Table 4.14: Cross-tabulations results for pain or discomfort related variables and several socio-demographic and mining-related variables**

| Variables | Category | pain or discomfort while working | | | pain or discomfort after work | | |
|---|---|---|---|---|---|---|---|
| | | less | Same | Worse | less | same | Worse |
| Mining site | Kwa Kitsi | 0.0% | 22.4% | 77.6% | 37.5% | 62.5% | 0.0% |
| | Ran mine | 0.0% | 0.0% | 100.0% | 13.0% | 87.0% | 0.0% |
| Age | 18 -25 years | 0.0% | 16.4% | 83.6% | 2.7% | 97.3% | 0.0% |
| | 26 -35 years | 0.0% | 5.1% | 94.9% | 32.8% | 67.2% | 0.0% |
| | 36 -45 years | 0.0% | 28.1% | 71.9% | 56.3% | 43.8% | 0.0% |
| | 46 -55 years | 0.0% | 13.6% | 86.4% | 63.6% | 36.4% | 0.0% |
| | >= 56 years | 0.0% | 42.9% | 57.1% | 21.4% | 78.6% | 0.0% |
| Marital status | Single | 0.0% | 13.2% | 86.8% | 35.8% | 64.2% | 0.0% |
| | Married | 0.0% | 12.4% | 87.6% | 26.7% | 73.3% | 0.0% |
| | Divorced | 0.0% | 57.1% | 42.9% | 42.9% | 57.1% | 0.0% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Artisanal mining experience | 6 – 12 months | 0.0% | 6.9% | 93.1% | 31.0% | 69.0% | 0.0% |
| | 13 – 24 months | 0.0% | 15.3% | 84.7% | 34.7% | 65.3% | 0.0% |
| | 25 –36 months | 0.0% | 22.2% | 77.8% | 11.1% | 88.9% | 0.0% |
| | > = 37months | 0.0% | 15.4% | 84.6% | 31.6% | 68.4% | 0.0% |
| Educational level | None | 0.0% | 12.5% | 87.5% | 27.5% | 72.5% | 0.0% |
| | Primary | 0.0% | 13.3% | 86.7% | 44.6% | 55.4% | 0.0% |
| | Secondary | 0.0% | 16.1% | 83.9% | 23.1% | 76.9% | 0.0% |
| | Tertiary | 0.0% | 15.4% | 84.6% | 15.4% | 84.6% | 0.0% |
| Other profession | Yes | 0.0% | 14.1% | 85.9% | 15.5% | 84.5% | 0.0% |
| | No | 0.0% | 14.9% | 85.1% | 33.5% | 66.5% | 0.0% |
| Full-time or part-time artisanal miner | full-time | 0.0% | 14.9% | 85.1% | 33.5% | 66.5% | 0.0% |
| | part-time | 0.0% | 14.1% | 85.9% | 15.5% | 84.5% | 0.0% |
| Mining status | self-employed | 0.0% | 16.7% | 83.3% | 34.3% | 65.7% | 0.0% |
| | Labourer | 0.0% | 9.2% | 90.8% | 14.5% | 85.5% | 0.0% |
| Site of work | Underground | *9 | 0.0% | 100.0% | 0.0% | 100.0% | 0.0% |
| | above ground | 0.0% | 0.0% | 100.0% | 12.5% | 87.5% | 0.0% |
| | Both | 0.0% | 17.7% | 82.3% | 33.3% | 66.7% | 0.0% |

**Table 4.15: Pearson Chi-Square Tests for pain or discomfort related variables and several socio-demographic and mining-related variables (all p-values < 0.05 means a statistically significant relationship)**

| Variable | pain or discomfort while working | | | pain or discomfort after work | | |
|---|---|---|---|---|---|---|
| | Chi-square | Df | Sig. | Chi-square | df | Sig. |
| Mining site | 26.263 | 1 | **0.000** | 19.126 | 1 | **0.000** |
| Age | 32.501 | 4 | **0.000** | 50.458 | 4 | **0.000** |
| Gender | 1.354 | 1 | 0.245 | 1.794 | 1 | 0.180 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Marital status | 21.089 | 2 | **0.000** | 3.099 | 2 | 0.212 |
| Artisanal mining experience | 4.903 | 3 | 0.179 | 8.626 | 3 | **0.035** |
| Educational level | 0.520 | 3 | 0.914 | 14.570 | 3 | **0.002** |
| Other profession | 0.031 | 1 | 0.861 | 8.429 | 1 | **0.004** |
| Role in family (breadwinner or not) | 0.119 | 1 | 0.730 | 0.739 | 1 | 0.390 |
| Full-time or part-time artisanal miner | 0.031 | 1 | 0.861 | 8.429 | 1 | **0.004** |
| Mining status | 2.489 | 1 | 0.115 | 10.665 | 1 | **0.001** |
| Site of work | 10.168 | 2 | **0.006** | 13.359 | 2 | **0.001** |

**Time off work caused by pain or discomfort**

Survey respondents were also asked to indicate if they had taken some time off work due to pain or discomfort within the last 6 months dating back from the day and time of data collection. Table 4.16 shows that majority of respondents' (n = 262; 91%) pain caused them to call for time-off from work, while the remaining 9% (n = 27) did not stop going to work. The results are as displayed in table 4.17 below.

**Table 4.17: Distribution of respondents for time-off work and number of days off**

| Variable | response | f | % |
|---|---|---|---|
| Time off work caused by pain or discomfort in the past six months | Yes | 265 | 90.8 |
| | No | 27 | 9.2 |
| | Total | 292 | 100.0 |
| Number of days off in all | 1-2days | 12 | 4.5 |
| | 3-4days | 131 | 49.4 |
| | 5+ days | 122 | 46.0 |
| | Total | 265 | 100.0 |

To determine if there was a relationship between calling for time-off work and several independent socio-demographic and mining-related variables, Chi-Squared tests for relationship were performed. The results are presented in tables 4.18 and 4.19.

The results in table 4.18 shows that calling for time-off work was significantly associated with marital status (Chi-Square = 8.86, df = 2, $p < 0.05$), artisanal mining experience (Chi-Square = 17.00, df = 3, $p < 0.05$) and artisanal role in the family (breadwinner or non-breadwinner) (Chi-Square = 6.60, df = 1, $p < 0.05$). The relationship between calling for time-off from work and marital status means that the extent to which artisanal miners calls for time off-work depends on their marital status; whether single, married or divorced. The results indicated that single and divorced artisanal miners are 1.13 times more likely to call for time off-work than married artisanal miners. This result might be attributed to the fact that married artisanal miners are driven by many family responsibilities which push them to go to work even if the pain requires the artisanal miners to call for some time off-work.

**Table 4.18: Cross-tabulation results between calling for time-off work and the socio-demographic and mining related independent variables**

| Variable | Category | Time-off work due to pain or discomfort in the past six months | | Number of off-sick days | | |
|---|---|---|---|---|---|---|
| | | Yes | No | 1-2days | 3-4days | 5+ days |
| mining site | Kwa Kitsi | 91.7% | 8.3% | 0.0% | 48.3% | 51.7% |
| | Ran mine | 89.0% | 11.0% | 13.5% | 51.7% | 34.8% |
| Age | 18 -25 years | 93.2% | 6.8% | 13.2% | 48.5% | 38.2% |
| | 26 -35 years | 87.6% | 12.4% | 2.5% | 57.5% | 40.0% |
| | 36 -45 years | 100.0% | 0.0% | 0.0% | 25.0% | 75.0% |
| | 46 -55 years | 86.4% | 13.6% | 0.0% | 57.9% | 42.1% |
| | >=56 years | 92.9% | 7.1% | 0.0% | 38.5% | 61.5% |
| Gender | Male | 90.6% | 9.4% | 3.3% | 54.1% | 42.6% |
| | Female | 91.1% | 8.9% | 7.3% | 39.0% | 53.7% |

| | | | | | | |
|---|---|---|---|---|---|---|
| Marital status | Single | 100.0% | 0.0% | 15.1% | 45.3% | 39.6% |
| | Married | 88.0% | 12.0% | 2.0% | 52.5% | 45.5% |
| | Divorced | 100.0% | 0.0% | 0.0% | 21.4% | 78.6% |
| Artisanal mining experience | 6months – 12 months | 100.0% | 0.0% | 8.6% | 46.6% | 44.8% |
| | 13months – 24months | 83.3% | 16.7% | 1.7% | 40.0% | 58.3% |
| | 25 months – 36 months | 100.0% | 0.0% | 2.2% | 62.2% | 35.6% |
| | >= 37months | 87.2% | 12.8% | 4.9% | 51.0% | 44.1% |
| Educational level | None | 97.5% | 2.5% | 0.0% | 69.2% | 30.8% |
| | Primary | 88.0% | 12.0% | 0.0% | 39.7% | 60.3% |
| | Secondary | 88.8% | 11.2% | 6.3% | 45.7% | 48.0% |
| | Tertiary | 100.0% | 0.0% | 15.4% | 65.4% | 19.2% |
| Other profession | Yes | 94.4% | 5.6% | 10.4% | 62.7% | 26.9% |
| | No | 89.6% | 10.4% | 2.5% | 44.9% | 52.5% |
| Role in the family (breadwinner or not) | Yes | 88.7% | 11.3% | 1.9% | 50.5% | 47.6% |
| | No | 100.0% | 0.0% | 15.1% | 45.3% | 39.6% |
| Full-time or part-time artisanal miners | full-time | 89.6% | 10.4% | 2.5% | 44.4% | 53.0% |
| | part-time | 94.4% | 5.6% | 10.4% | 64.2% | 25.4% |
| Mining status | self-employed | 89.4% | 10.6% | 2.6% | 43.5% | 53.9% |
| | Labourer | 94.7% | 5.3% | 9.7% | 65.3% | 25.0% |
| Site of work | Underground | 82.4% | 17.6% | 28.6% | 42.9% | 28.6% |
| | above ground | 75.0% | 25.0% | 8.3% | 66.7% | 25.0% |
| | Both | 93.4% | 6.6% | 2.6% | 48.0% | 49.3% |

**Table 4.19: Pearson Chi-Square Tests summarising test for relationships between calling for time-off work and the socio-demographic and mining related independent variables (all p-values < 0.05 means a statistically significant relationship)**

| Variable | Time-off work due to pain or discomfort in the past six months | | | Number of off-sick days | | |
|---|---|---|---|---|---|---|
| | Chi-square | df | Sig. | Chi-square | df | Sig. |
| mining site | 0.557 | 1 | 0.455 | 27.523 | 2 | **0.000** |
| Age | 6.046 | 4 | 0.196 | 31.426 | 8 | **0.000** |
| Gender | 0.020 | 1 | 0.888 | 6.140 | 2 | **0.046** |
| Marital status | 8.859 | 2 | **0.012** | 22.947 | 4 | **0.000** |
| Artisanal mining experience | 16.999 | 3 | **0.001** | 9.650 | 6 | 0.140 |
| Educational level | 6.238 | 3 | 0.101 | 28.261 | 6 | **0.000** |
| Other profession | 1.459 | 1 | 0.227 | 17.284 | 2 | **0.000** |
| Role in the family (breadwinner or not) | 6.597 | 1 | **0.010** | 17.156 | 2 | **0.000** |
| Full-time or part-time artisanal miners | 1.459 | 1 | 0.227 | 19.200 | 2 | **0.000** |
| Mining status | 1.943 | 1 | 0.163 | 20.414 | 2 | **0.000** |
| Site of work | 12.946 | 2 | **0.002** | 25.850 | 4 | **0.000** |

### 4.4.3 Interference of pain or discomfort with work

Statistical results describing how pain or discomfort interferes with artisanal mining are presented. The results describe interference of pain or discomfort on work, life outside work and sleep.

#### 4.4.3.1 Pain or discomfort on work

The majority of respondents (n = 242; 83%) had to call for time off-work due to pain, 12% (n = 36) reported that the pain had some interference with their work while the remaining 5% (n

= 14) reported that pain had no interference with their work (see table 4.20 below). On average, artisanal miners had to take time off-work due to pain.

#### 4.4.3.2 Pain or discomfort on life outside of work

Table 4.20 shows that majority of respondents (n = 242; 83%) had to stop enjoying some activities due to pain, 12.3% (n = 36) had some interference with their lives outside work and 5% (n = 14) reported that the pain did not interfere with their lives outside work. On average, artisanal miners had to stop enjoying life activities due to pain or discomfort.

#### 4.4.3.3 Pain or discomfort on sleep

Table 4.20 shows that majority of respondents (n = 242; 83%) reported that pain or discomfort affected them every night when they go to sleep, 12% (n = 36) reported that pain or discomfort interfered their sleep and only 5% (n =14) reported that pain or discomfort did not interfere with their sleep. On average, pain or discomfort interfered with the sleep of artisanal miners every night.

**Table 4.20: Frequency table describing interference of pain or discomfort on work, life outside work and sleep of artisanal miners**

| Variable | Response | F | % |
|---|---|---|---|
| Pain or discomfort interference with work | No interference | 14 | 4.8 |
| | Some interference | 36 | 12.3 |
| | Had to take time off work due to pain | 242 | 82.9 |
| | Total | 292 | 100.0 |
| Pain or discomfort interference with life outside of work | No interference | 14 | 4.8 |
| | Some interference | 36 | 12.3 |
| | Had to stop enjoying activity due to pain | 242 | 82.9 |
| | Total | 292 | 100.0 |
| Pain or discomfort interference with sleep | No interference | 14 | 4.8 |
| | Some interference | 36 | 12.3 |
| | It affects me every night | 242 | 82.9 |

| | | | |
|---|---|---|---|
| | Total | 292 | 100.0 |

**Chi-Square test for relationship**

Chi-squared tests of relationship results summarising the relationship between the interference of pain (on work, life outside work and sleep) and the socio-demographic and mining-related variables are presented.

The results show that statistically significant relationship exist between interference of pain with work and mining site (Chi-Square = 6.65, $p < 0.05$), age (Chi-Square = 24.98, $p < 0.05$), artisanal mining experience (Chi-Square = 31.11, $p < 0.05$), mining status (Chi-Square = 6.40, $p < 0.05$) and site of work (Chi-Square = 99.80, $p < 0.05$). The results show that pain causes artisanal miners from Kwa Kitsi to take some time off-work more than artisanal miners from Ran Mine (see results in table 4.21 below). For instance, 87% of artisanal miners from Kwa Kitsi suffered pain which caused them to call for time off-work, which is relative to 75% of artisanal miners from Ran mine. Interestingly, interference of pain or discomfort outside work and sleep is significantly associated with the same socio-demographic and mining related variables (mining site, age, mining experience, mining status and site of work) as reported above on the interference of pain with the work of artisanal miners (see tables 4.21 and 4.22 for detailed results).

**Table 4.21: Cross-tabulations between inference of pain with work, life outside work and sleep versus socio-demographic and mining-related independent variables**

| Variable | | Pain or discomfort interference with work | | | Pain or discomfort interference with life outside of work | | | Pain or discomfort interference with sleep | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | No interference | Some interference | Had to take time off work due to pain | No interference | Some interference | Had to stop enjoying activity due to pain | No interference | Some interference | It affects me every night |
| Mining site | Kwa Kitsi | 3.6% | 9.4% | 87.0% | 3.6% | 9.4% | 87.0% | 3.6% | 9.4% | 87.0% |
| | Ran mine | 7.0% | 18.0% | 75.0% | 7.0% | 18.0% | 75.0% | 7.0% | 18.0% | 75.0% |
| Age | 18 -25 years | 4.1% | 8.2% | 87.7% | 4.1% | 8.2% | 87.7% | 4.1% | 8.2% | 87.7% |
| | 26 -35 years | 3.6% | 21.2% | 75.2% | 3.6% | 21.2% | 75.2% | 3.6% | 21.2% | 75.2% |
| | 36 -45 years | 3.1% | 0.0% | 96.9% | 3.1% | 0.0% | 96.9% | 3.1% | 0.0% | 96.9% |
| | 46 -55 years | 13.6% | 4.5% | 81.8% | 13.6% | 4.5% | 81.8% | 13.6% | 4.5% | 81.8% |
| | >=56 years | 7.1% | 0.0% | 92.9% | 7.1% | 0.0% | 92.9% | 7.1% | 0.0% | 92.9% |
| Artisanal mining experience | 6 –12 months | 1.7% | 6.9% | 91.4% | 1.7% | 6.9% | 91.4% | 1.7% | 6.9% | 91.4% |
| | 13 –24 months | 5.6% | 27.8% | 66.7% | 5.6% | 27.8% | 66.7% | 5.6% | 27.8% | 66.7% |
| | 25 – 36 months | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | 100.0% | 0.0% | 0.0% | 100.0% |
| | >=37months | 7.7% | 10.3% | 82.1% | 7.7% | 10.3% | 82.1% | 7.7% | 10.3% | 82.1% |
| Mining status | self-employed | 6.0% | 14.4% | 79.6% | 6.0% | 14.4% | 79.6% | 6.0% | 14.4% | 79.6% |
| | Labourer | 1.3% | 6.6% | 92.1% | 1.3% | 6.6% | 92.1% | 1.3% | 6.6% | 92.1% |
| Site of work | Underground | 5.9% | 82.4% | 11.8% | 5.9% | 82.4% | 11.8% | 5.9% | 82.4% | 11.8% |
| | above ground | 18.8% | 12.5% | 68.8% | 18.8% | 12.5% | 68.8% | 18.8% | 12.5% | 68.8% |
| | Both | 2.9% | 7.4% | 89.7% | 2.9% | 7.4% | 89.7% | 2.9% | 7.4% | 89.7% |

**Table 4.22: Pearson Chi-Square Tests for pain or discomfort interference related variables and several socio-demographic and mining-related variables (p-values < 0.05 means a statistically significant relationship)**

| Variable | Pain or discomfort interference with work | | | Pain or discomfort interference with life outside of work | | | Pain or discomfort interference with sleep | | |
|---|---|---|---|---|---|---|---|---|---|
| | Chi-square | df | Sig. | Chi-square | df | Sig. | Chi-square | df | Sig. |
| Mining site | 6.649 | 2 | **0.036** | 6.649 | 2 | **0.036** | 6.649 | 2 | **0.036** |
| Age | 24.979 | 8 | **0.002** | 24.979 | 8 | **0.002** | 24.979 | 8 | **0.002** |
| Gender | 1.114 | 2 | 0.573 | 1.114 | 2 | 0.573 | 1.114 | 2 | 0.573 |
| Marital status | 5.623 | 4 | 0.229 | 5.623 | 4 | 0.229 | 5.623 | 4 | 0.229 |
| Artisanal mining experience | 31.107 | 6 | **0.000** | 31.107 | 6 | **0.000** | 31.107 | 6 | **0.000** |
| Educational level | 12.005 | 6 | 0.062 | 12.005 | 6 | 0.062 | 12.005 | 6 | 0.062 |
| Other profession | 5.221 | 2 | 0.073 | 5.221 | 2 | 0.073 | 5.221 | 2 | 0.073 |
| Role in the family (breadwinner or not) | 2.938 | 2 | 0.230 | 2.938 | 2 | 0.230 | 2.938 | 2 | 0.230 |
| Full-time or part-time artisanal miners | 5.221 | 2 | 0.073 | 5.221 | 2 | 0.073 | 5.221 | 2 | 0.073 |
| Mining status | 6.404 | 2 | **0.041** | 6.404 | 2 | **0.041** | 6.404 | 2 | **0.041** |
| Site of work | 99.797 | 4 | **0.000** | 99.797 | 4 | **0.000** | 99.797 | 4 | **0.000** |

### 4.4.4 OTHER HEALTH PROBLEMS

Respondents were also asked if they experienced other health problems related to their work. Data analysis shows that majority of respondents (n = 197; 67%) had no other health challenges related to artisanal mining, while the remaining 33% (n = 95) reported that they had other work-related health issues.

**Table 4.23: Frequency table showing the distribution of respondents with or without other health problems**

| Response | Number | Percent% |
|---|---|---|
| Yes | 95 | 33 |
| No | 197 | 67 |
| Total | 292 | 100 |

To determine the level of relationship between having other health problems related to work (yes/no) dependent variables, several socio-demographic, mining-related independent variables and cross-tabulations were carried out between the dependent and independent variables. The results, as presented in table 4.24 below, shows that there was a statistically significant relationship between having other health problems related to work and mining site (Chi-Square = 12.69, $p < 0.05$), age (Chi-Square = 22.96, $p < 0.05$), marital status (Chi-Square = 9.87, $p < 0.05$), other profession (Chi-Square = 5.56, $p < 0.05$), full-time or part-time artisanal miner (Chi-Square = 5.56, $p < 0.05$), mining status (Chi-Square = 4.84, $p < 0.05$). A statistically significant relationship between having other work-related health problems and mining site means that artisanal miners had or had no other work-related health problems depending on the location or area they work (Ran or Kwa-Kitsi). The results show that 39.6% of total respondents from Kwa Kisti had other work-related health problems compared to 19.0% of the total respondents from Ran Mine who revealed that they had other work-related health problems. To restate, artisanal miners from Kwa Kitsi are 2 times more likely to have other work-related health problems than artisanal miners from Ran mine.

Further, cross-tabulations involving other work-related health problems, mining site and age revealed that having other health problems related to work and age was statistically significant for Kwa Kisti mine (Chi-square = 31.86, $p < 0.05$), while statistically insignificant for Ran Mine (Chi-square = 5.85, $p = 0.211$). These results show that artisanal miners from Kwa Kitsi aged between 26 and 45 years had other work-related health problems. These results are important for intervention programs aimed at improving health and safety conditions for artisanal miners, which contributes to increased efficiency and effectiveness. Table 4.24 and 4.25 provides summary results for the tests of relationship.

**Table 4.24: Cross-tabulation results between "having other health problems related to work" and the socio-demographic and mining-related independent variables**

| Variable | Category | Experience with other work-related health problems | |
|---|---|---|---|
| | | Yes | No |
| Mining site | Kwa Kitsi | 39.6% | 60.4% |
| | Ran mine | 19.0% | 81.0% |
| Age | 18 -25 years | 23.3% | 76.7% |
| | 26 -35 years | 39.4% | 60.6% |
| | 36 -45 years | 53.1% | 46.9% |
| | 46 -55 years | 27.3% | 72.7% |
| | >= 56 years | 3.6% | 96.4% |
| Marital status | single | 24.5% | 75.5% |
| | married | 36.4% | 63.6% |
| | divorced | 0.0% | 100.0% |
| Other profession | Yes | 21.1% | 78.9% |
| | No | 36.2% | 63.8% |
| Full-time or part-time artisanal miners | full-time | 36.2% | 63.8% |
| | part-time | 21.1% | 78.9% |
| Mining status | self-employed | 36.1% | 63.9% |
| | labourer | 22.4% | 77.6% |

**Table 4.25: Pearson Chi-Square Tests for "having other health problems related to work" and the socio-demographic and mining-related independent variables (p-values < 0.05 means a statistically significant relationship)**

| Variable | Experience with other work-related health problems | | |
|---|---|---|---|
| | Chi-square | Df | Sig. |
| Mining site | 12.692 | 1 | **0.000** |
| Age | 22.959 | 4 | **0.000** |
| Gender | 0.541 | 1 | 0.462 |
| Marital status | 9.866 | 2 | **0.007** |
| Artisanal mining experience | 3.925 | 3 | 0.270 |
| Educational level | 1.918 | 3 | 0.590 |
| Other profession | 5.562 | 1 | **0.018** |
| Role in the family (breadwinner or not) | 2.887 | 1 | 0.089 |
| Full-time or part-time artisanal miners | 5.562 | 1 | **0.018** |
| Mining status | 4.837 | 1 | **0.028** |
| Site of work | 3.307 | 2 | 0.191 |

## 4.5 CHEMICAL AGENTS

Statistical results describing variables related to chemical agents are presented. The results are on artisanal miners' exposure to chemicals, extraction of potentially harmful gases and their types, mixture of chemicals during processing, use of personal protective equipment (PPEs) when handling chemicals, possibility of inhaling dust particles and availability of facilities to wash hands after using chemicals.

### 4.5.1 Exposure of miners to chemicals

Table 4.26 present results summarizing respondents' responses to the question; Are workers exposed to chemicals that could affect their normal physical or mental functioning in short or long term. As shown in the table below, all 292 respondents agreed that they were exposed to chemicals that are harmful to their normal physical or mental functioning in the short-or long-term.

**Table 4.26: Distribution of respondents according to their exposure to chemicals**

| Response | Number | Percent% |
|---|---|---|
| Yes | 292 | 100 |

#### 4.5.1.1 Types of chemicals

Respondents who agreed that they were exposed to harmful chemicals were further asked to indicate the types of chemicals they used during the mining process. The results are as shown in figure 4.4.

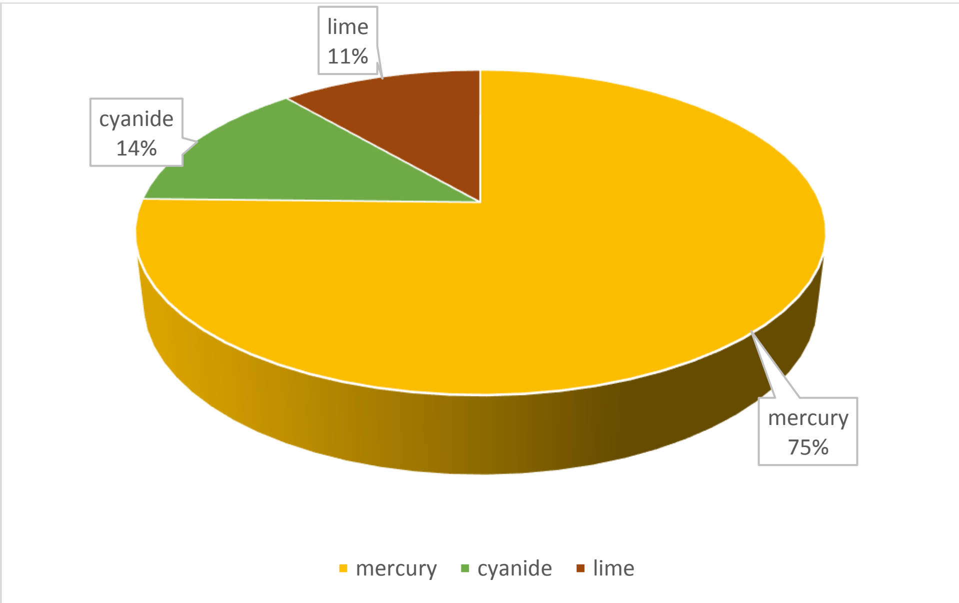



Figure 4. 5: Pie chart showing distribution of chemicals used by respondents

The results, as displayed in figure 4.4 above, reveal that majority 75% respondents used mercury, 14% used cyanide and 11% used lime in their mining processes.

### 4.5.2 Extraction of potentially harmful gases

Table 4.27 present a summary of responses to the question; Does the mining processes extract any potentially harmful gases? The results below show that majority of respondents 80% (n = 234) perform mining processes that involve the extraction of potentially harmful gases, and the remaining 20% (n = 58) of mining processes involve non-extraction of potentially harmful gases.

**Table 4.27: Distribution of respondents' exposure to harmful gases**

| Response | Number | Percent % |
|---|---|---|
| Yes | 234 | 80 |
| No | 58 | 20 |
| Total | 292 | 100 |

### 4.5.3 Types of gases extracted

Respondents who revealed that the mining processes extracted potentially harmful gases were further asked to highlight the types of gases that the mining process extracted. The results depicted in figure 4.5 below shows that of the 234 respondents who reported that they were exposed to harmful gases, majority (n = 207; 88%) revealed that they were exposed to mercury vapor, while the remaining 12% (n = 27) reported being exposed to other gases.

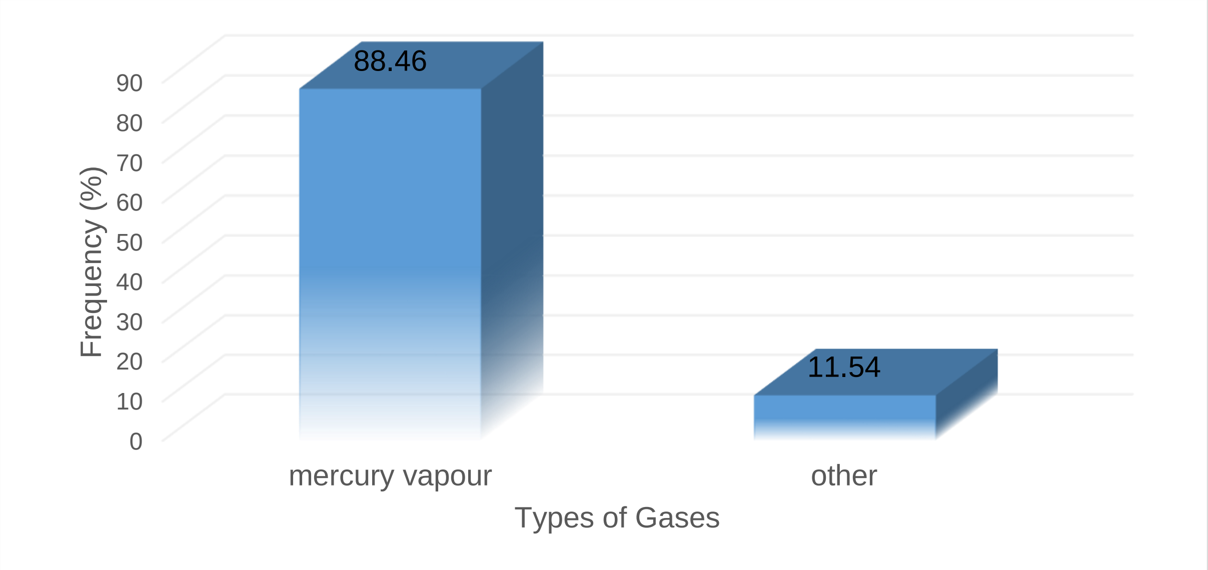



Figure 4. 6: Type of gases exposed to survey respondents

#### 4.5.3 Mixture of chemicals during processing

Table 4.28 presents the frequency distribution of responses to the question; Does the process allow the chemicals to be mixed? As clearly shown in table 4.28, all 292 respondents agreed that the process allow chemicals to be mixed.

**Table 4.28: Distribution of respondents who mix chemicals in their mining process**

| Response | Number | Percent (%) |
|---|---|---|
| Yes | 292 | 100 |

### 4.5.4 Use of personal protective equipment (PPEs) when handling chemicals

Following up on the result which established that the mining process allow chemicals to be mixed, it became instructive for the researcher to ask the respondents to indicate if they used personal protective equipment (PPEs). Consequently, respondents were asked; Do you use any personal protective equipment when handling chemicals? and the results are presented in table 4.29. All respondents (n = 292; 100%) confirmed that they do not wear personal protective clothing when handling chemicals.

**Table 4.29: Distribution of respondents by the use of protective clothing (PPE) when handling chemicals**

| Response | Number | Percent (%) |
|---|---|---|
| No | 292 | 100 |

### 4.5.5 Possibility to inhale dust particles

In addition to handling chemicals during mining processes, respondents were also asked to indicate if they inhale dust particles in any of the mining processes. Responses to the question "Do you inhale dust particles in any of the processes?" are summarized in table 4.30 below. The results show that majority of respondents (n =178; 61%) inhale dust particles at work and the remaining 39% (n = 114) revealed that there are no dust particles at their workplaces (see table 4.30)

**Table 4.30: Frequency distribution summarizing responses to question on the presence of dust particles**

| Response | Number | Percentage |
|---|---|---|
| Yes | 178 | 61 |
| No | 114 | 39 |
| Total | 292 | 100 |

### 4.5.6 Availability of facilities for washing hands

After asking artisanal miners whether their mining processes mixed chemicals, whether respondents wore any personal protective equipment, the researcher further asked them to indicate if their workplaces had facilities for them to wash hands after using hazardous chemicals. The results are as shown in table 4.31 below.

**Table 4.31: Distribution of respondents by presence of washing facilities at workplaces**

| Response | Number | Percent (%) |
|---|---|---|
| Yes | 25 | 9 |
| No | 267 | 91 |
| Total | 292 | 100 |

Table 4.31 shows that majority of respondents (n = 267; 91%) had no facilities for them to wash their hands at work, while the remaining 9% (n = 25) admitted that they had washing facilities at their workplaces. This means that almost 9 in every 10 artisanal miners are at the risk of being exposed to chemical agents due to lack of facilities to wash their hands at workplaces post chemical contact during mining processes.

### 4.5.7 Cross-tabulations

Chi-Squared tests of relationship results summarising the nature of relationship between dependent chemical agents-related variables, independent socio-demographic and mining-related variables are presented.

#### 4.5.7.1 Extraction of potentially harmful gases

Chi-Squared tests results revealed the existence of a statistically significant relationship between extraction of potentially harmful gases and age, marital status, artisanal mining experience, educational level, other profession, role in the family (breadwinner or not), full-time or part-time artisanal miners, mining status and site of work. A statistically significant relationship between extraction of potentially harmful gases and marital status implies that the extent to which respondents agree or disagree that the mining processes involved the extraction of potentially harmful gases depends on whether survey respondents are single, married or divorced. The results particularly show that single and divorced artisanal miners admitted that mining processes involved the extraction of potentially harmful gases. In contrast, not all married artisanal miners agreed that the process involved the extraction of potentially harmful gases.

#### 4.5.7.2 Type of gases

Chi-Squared test results revealed the existence of a statistically significant relationship between type of gases and mining site, age, marital status as well as role in the family (breadwinner or not). A statistically significant relationship means that the types of gases extracted during the mining process depends on mining site (Ran Mine or Kwa Kitsi). The results show that more mercury vapour is extracted at Kwa Kitsi mine (93.3%), compared to Ran Mine (80%). Conversely, other forms of gases are produced at Ran Mine (20%), compared to Kwa Kisti mine (6.7%). These results are important for future intervention programs as well as future research studies. For instance, health and safety measures for minimizing the risk of exposure to mercury vapour should be targeted at artisanal miners from Kwa Kitsi more than artisanal miners from Ran mine. This is due to the realisation that Kwa Kitsi mine is 1.16 times more likely to suffer from the risk of mercury vapour exposure than artisanal miners from Ran mine.

#### 4.5.7.3 Inhalation of dust particles

Statistically significant relationship was reported between inhalation of dust particles and mining site, marital status, artisanal mining experience, role in the family (breadwinner or not) and site of work. A statistically significant relationship between inhalation of dust particles and mining site, for example, means that the extent to which artisanal miners agrees or disagrees that they inhale dust particles depends on their mining site (Kwa Kitsi or Ran mine). For instance, the results revealed that Ran Mine (76.0%) had a higher number of artisanal miners who inhaled dust participles compared to Kwa Kitsi Mine (53.1%).

#### 4.5.7.4 Availability of facilities for washing hands

Chi-Square tests of relationship revealed that a statistically significant relationship between the availability of facilities to wash hands after using chemicals and gender, marital status, artisanal mining experience, role in the family (breadwinner or not) as well as site of work. A statistically significant relationship between availability of facilities to wash hands after using chemicals and gender implies that the extent to which respondents agree or disagree to the availability of facilities to wash hands after using chemicals depends on gender of the respondents (male or female). For instance, the results show that all females (100%) disagreed that there are facilities to wash hands after using chemicals at their workplace, while some of the male (12.4% of the male respondents) artisanal miners agreed that facilities to wash hands after using chemicals are available. For complete results on tests of relationship, refer to tables 4.32 and 4.33.

**Table 4.32: Cross-tabulation results for chemical agents related variables and several socio-demographic and mining-related variables.**

| Variable | Category | Extraction of any potentially harmful gases | | Type of gases | | Inhalation of dust particles | | Availability of facilities for washing hands after using chemicals | |
|---|---|---|---|---|---|---|---|---|---|
| | | Yes | No | mercury vapour | others | Yes | No | yes | No |
| Mining site | Kwa Kitsi | 77.6% | 22.4% | 93.3% | 6.7% | 53.1% | 46.9% | 6.8% | 93.2% |
| | Ran mine | 85.0% | 15.0% | 80.0% | 20.0% | 76.0% | 24.0% | 12.0% | 88.0% |
| Age | 18 -25 years | 94.5% | 5.5% | 92.8% | 7.2% | 68.5% | 31.5% | 11.0% | 89.0% |
| | 26 -35 years | 67.9% | 32.1% | 83.9% | 16.1% | 56.2% | 43.8% | 6.6% | 93.4% |
| | 36 -45 years | 100.0% | 0.0% | 78.1% | 21.9% | 53.1% | 46.9% | 0.0% | 100.0% |
| | 46 -55 years | 68.2% | 31.8% | 100.0% | 0.0% | 72.7% | 27.3% | 13.6% | 86.4% |
| | > = 56 years | 89.3% | 10.7% | 100.0% | 0.0% | 64.3% | 35.7% | 17.9% | 82.1% |
| Gender | Male | 77.2% | 22.8% | 86.5% | 13.5% | 59.4% | 40.6% | 12.4% | 87.6% |
| | Female | 86.7% | 13.3% | 92.3% | 7.7% | 64.4% | 35.6% | 0.0% | 100.0% |
| Marital status | Single | 100.0% | 0.0% | 98.1% | 1.9% | 77.4% | 22.6% | 0.0% | 100.0% |
| | Married | 74.2% | 25.8% | 84.4% | 15.6% | 57.8% | 42.2% | 9.8% | 90.2% |
| | Divorced | 100.0% | 0.0% | 100.0% | 0.0% | 50.0% | 50.0% | 21.4% | 78.6% |
| Artisanal mining experience | 6 –12 months | 84.5% | 15.5% | 95.9% | 4.1% | 77.6% | 22.4% | 0.0% | 100.0% |
| | 13–24 months | 59.7% | 40.3% | 83.7% | 16.3% | 52.8% | 47.2% | 16.7% | 83.3% |
| | 25–36 months | 88.9% | 11.1% | 82.5% | 17.5% | 44.4% | 55.6% | 13.3% | 86.7% |
| | >=37months | 87.2% | 12.8% | 89.2% | 10.8% | 64.1% | 35.9% | 6.0% | 94.0% |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Educational level | None | 95.0% | 5.0% | 89.5% | 10.5% | 65.0% | 35.0% | 5.0% | 95.0% |
| | Primary | 72.3% | 27.7% | 88.3% | 11.7% | 59.0% | 41.0% | 9.6% | 90.4% |
| | Secondary | 77.6% | 22.4% | 88.3% | 11.7% | 59.4% | 40.6% | 9.1% | 90.9% |
| | Tertiary | 96.2% | 3.8% | 88.0% | 12.0% | 69.2% | 30.8% | 7.7% | 92.3% |
| Other profession | Yes | 97.2% | 2.8% | 85.5% | 14.5% | 66.2% | 33.8% | 9.9% | 90.1% |
| | No | 74.7% | 25.3% | 89.7% | 10.3% | 59.3% | 40.7% | 8.1% | 91.9% |
| Role in the family | Yes | 75.7% | 24.3% | 85.6% | 14.4% | 57.7% | 42.3% | 10.5% | 89.5% |
| | No | 100.0% | 0.0% | 98.1% | 1.9% | 75.5% | 24.5% | 0.0% | 100.0% |
| Full-time or part-time artisanal miners | Full-time | 74.7% | 25.3% | 89.7% | 10.3% | 59.3% | 40.7% | 8.1% | 91.9% |
| | Part-time | 97.2% | 2.8% | 85.5% | 14.5% | 66.2% | 33.8% | 9.9% | 90.1% |
| Mining status | Self-employed | 74.1% | 25.9% | 89.4% | 10.6% | 59.7% | 40.3% | 9.3% | 90.7% |
| | Labourer | 97.4% | 2.6% | 86.5% | 13.5% | 64.5% | 35.5% | 6.6% | 93.4% |
| Site of work | Underground | 94.1% | 5.9% | 100.0% | 0.0% | 70.6% | 29.4% | 41.2% | 58.8% |
| | Above ground | 59.4% | 40.6% | 100.0% | 0.0% | 84.4% | 15.6% | 15.6% | 84.4% |
| | Both | 81.9% | 18.1% | 86.4% | 13.6% | 57.2% | 42.8% | 5.3% | 94.7% |

**Table 4.33: Pearson Chi-Square Tests (Chi-square, degrees of freedom and p-values)**

| Variable | Extraction of any potentially harmful gases | | | Type of gases | | | Inhalation of dust particles | | | Availability of facilities for washing hands after using chemicals | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chi-square | df | Sig. | Chi-square | df | Sig. | Chi-square | df | Sig. | Chi-square | df | Sig. |
| mining site | 2.260 | 1 | 0.133 | 9.364 | 1 | **0.002** | 14.457 | 1 | **0.000** | 2.297 | 1 | 0.130 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 33.791 | 4 | **0.000** | 11.732 | 4 | **0.019** | 5.278 | 4 | 0.260 | 8.041 | 4 | 0.090 |
| Gender | 3.485 | 1 | 0.062 | 1.696 | 1 | 0.193 | 0.664 | 1 | 0.415 | 12.182 | 1 | **0.000** |
| Marital status | 21.552 | 2 | **0.000** | 9.321 | 2 | **0.009** | 7.653 | 2 | **0.022** | 8.348 | 2 | **0.015** |
| Artisanal mining experience | 25.350 | 3 | **0.000** | 5.066 | 3 | 0.167 | 14.405 | 3 | **0.002** | 13.775 | 3 | **0.003** |
| Educational level | 13.521 | 3 | **0.004** | 0.048 | 3 | 0.997 | 1.289 | 3 | 0.732 | 0.847 | 3 | 0.838 |
| Other profession | 17.125 | 1 | **0.000** | 0.837 | 1 | 0.360 | 1.082 | 1 | 0.298 | 0.202 | 1 | 0.653 |
| Role in the family (breadwinner or not) | 16.050 | 1 | **0.000** | 6.253 | 1 | **0.012** | 5.731 | 1 | **0.017** | 6.063 | 1 | **0.014** |
| Full-time or part-time artisanal miners | 17.125 | 1 | **0.000** | 0.837 | 1 | 0.360 | 1.082 | 1 | 0.298 | 0.202 | 1 | 0.653 |
| Mining status | 19.165 | 1 | **0.000** | 0.414 | 1 | 0.520 | 0.533 | 1 | 0.465 | 0.516 | 1 | 0.473 |
| Site of work | 11.224 | 2 | **0.004** | 5.368 | 2 | 0.068 | 9.476 | 2 | **0.009** | 28.340 | 2 | **0.000** |

p-values < 0.05 means a statistically significant relationship

## 4.6 PSYCHOSOCIAL ISSUES

This section presents statistical results for psycho-social issues' proxy variables. The results are on the exposure of artisanal miners to sexual harassment, bullying, violence at work, faith, culture or language issues, existing or non-existing systems for complains, family support of the work, work-induced depression or stress, job satisfaction, drinking alcohol, smoking and the types of food consumed.

### 4.6.1 Harassment

The results in table 4.34 shows that majority of respondents (n = 274; 93.8%) were never harassed at work and the remaining 6% (n = 18) reported that they had been harassed at work. Thus, approximately 1 in every 10 artisanal miners is subjected to harassment at work. However, on average, artisanal miners are not harassed at work.

**Table 4.34: Distribution of respondents by their status of harassment at work**

| Response | Number | Percent (%) |
|---|---|---|
| Yes | 18 | 6 |
| No | 274 | 94 |
| Total | 292 | 100 |

### 4.6.2 Bullying

The tabulated results below show that majority of respondents (n = 215; 74%) reported that they had been bullied at work, and the remaining 26% (n = 77) were not bullied at work (see table 4.35). Therefore, nearly 7 in every 10 artisanal miners are bullied at work, while nearly 3 in every 10 artisanal miners are not bullied at work. On average, artisanal miners are exposed to bullying at work.

**Table 4.35: Distribution of frequencies by whether respondents were bullied at work or not**

| Response | Number | Percent (%) |
|---|---|---|
| Yes | 215 | 74 |
| No | 77 | 26 |
| Total | 292 | 100 |

### 4.6.3 Violence

Table 4.36 shows that majority of respondents (n = 201; 69%) were involved in violence at work, while the remaining 31% (n = 91) were never involved in violence at work. Hence, nearly 7 in every 10 artisanal miners are exposed to the risk of violence at work and nearly 3 in every 10 artisanal miners are free from violent threats at work. On average, artisanal miners are exposed to the risk of violence at work.

**Table 4.36: Distribution of frequencies by whether respondents had been involved in violence at work**

| Response | Number | Percentage (%) |
|---|---|---|
| Yes | 201 | 69 |
| No | 91 | 31 |
| Total | 291 | 100 |

#### 4.6.4 Faith, culture or language issues

Table 4.37 shows that a small proportion (n =115; 39%) of respondents had cultural, faith and language issues at work and the majority of respondents reported that they had no language or faith issues at work. Hence, nearly 4 in very 10 artisanal miners have culture, faith and language issues at work while, 6 in very 10 miners have no culture, faith and language issues at work. On average, respondents reported that culture, faith and language issues did not give them a challenge at work.

**Table 4.37: Distribution of frequencies by whether or not respondents had faith, culture or language issues**

| Response | Number | Percent% |
|---|---|---|
| Yes | 115 | 39 |
| No | 177 | 61 |
| Total | 292 | 100 |

#### 4.6.5 Systems in place to pass complains

Table 4.38 shows that all respondents (n = 292; 100%) had complains related systems in place at their respective mining sites.

**Table 4.38: Distribution of frequencies by whether or not respondents agreed that there are systems in place for passing complains**

| Response | Number | Percent% |
|---|---|---|
| No | 292 | 100 |

### 4.6.6 Family friendliness of the work

Results in table 4.39 shows that all respondents (n = 292; 100%) reported that their work separated them from their families.

**Table 4.39: Distribution of frequencies by whether or not respondents agreed that their work took them away from their families**

| Response | Number | Percentage |
|---|---|---|
| Yes | 292 | 100% |

### 4.6.7 Work-induced depression or stress

Table 4.40 shows that majority of respondents (n = 215; 74%) sometimes get depressed and stressed due to work, 18% (n = 52) of the respondents reported that they do not get depressed or stressed due to work and the remaining 8% (n = 25) established that they are not sure of ever-getting stressed or depressed due to work. Hence, nearly 7 in every 10 artisanal miners are exposed to work-related depression and stress, 2 in every 10 artisanal miners are not exposed to the risk of work-related depression and stress and 1 in every 10 remain unsure of their exposure to depression and stress. On average, artisanal miners are exposed to work-related depression or stress.

**Table 4.40: Distribution of frequencies by whether or not respondents agreed that they get depressed or stressed due to work**

| Response | Name | Percent% |
|---|---|---|
| Yes | 215 | 74 |
| No | 52 | 18 |
| Not sure | 25 | 8 |

| | | |
|---|---|---|
| Total | 292 | 100 |

### 4.6.8 Job satisfaction

Table 4.41 shows that majority of respondents (n = 233; 80%) are not satisfied with their job, 11% (n = 32) are satisfied with their job and the remainder 9% (n = 27) is not sure. Hence, 8 in every 10 artisanal miners are dissatisfied with their jobs while nearly 2 in every 10 artisanal miners are equally satisfied and unsure of their level of satisfaction with their job. On average, artisanal miners are not satisfied with their job.

**Table 4.41: Distribution of frequencies by whether or not respondents are satisfied with their jobs**

| Response | Number | Percent |
|---|---|---|
| Yes | 32 | 11 |
| No | 233 | 80 |
| Not sure | 27 | 9 |
| Total | 292 | 100 |

### 4.6.9 Drinking alcohol and smoking

Table 4.42 shows that majority of respondents (n = 204; 70%) drink alcohol and the remainder 30% (n = 88) do not consume alcohol. Therefore, 7 in very 10 artisanal miners consume alcohol and the remaining 3 in every 10 artisanal miners do not take alcohol. On average, artisanal miners drink alcohol. The results in table 4.42 below also show that the majority of respondents (n = 190; 65%) are smokers and the remaining 35% (n= 102) are non-smokers. Thus, nearly 7 in every 10 artisanal miners are smokers and the remaining 3 in every 10 artisanal miners are non-smokers. Overall, artisanal miners smoke.

**Table 4.42: Distribution of frequencies by whether or not respondents were smoking and drinking alcohol**

| | Yes | No | Total |
|---|---|---|---|
| Alcohol | 204 | 88 | 292 |
| Alcohol (%) | 70 | 30 | 100 |

| | | | |
|---|---|---|---|
| Smoking | 190 | 102 | 292 |
| Smoking (%) | 65 | 35 | 100 |

#### 4.6.10 Type of food eaten

Figure 4.6 shows that most respondents (n = 200; 68%) reported that they usually eat bread and soft drinks at work, followed by 24% (n = 70) who eat porridge (*sadza)* and meat at work while, the remaining 8% (n = 22) eat rice at work. Hence, 7 in every 10 artisanal miners eat bread and soft drinks at work, 2 in every 10 artisanal miners eat porridge (*sadza*) and meat, while nearly 1 in every 10 artisanal miners eat rice at work. On average, artisanal miners consume bread and soft drinks as their main meal at work.

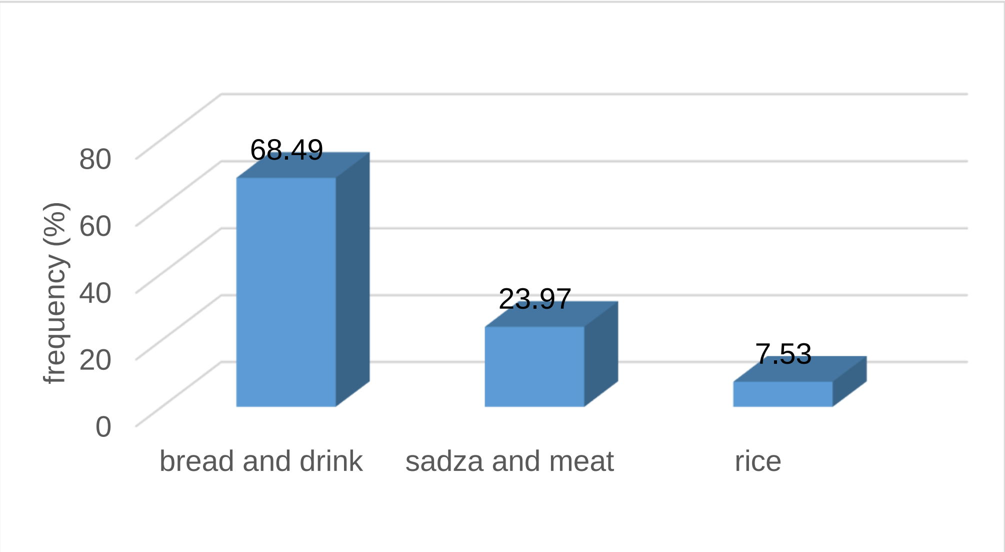



Figure 4.7: Type of food the participants' eat at work

#### 4.6.11 Chi-Squared Tests for Relationship

Chi-Squared test results to ascertain the level of relationship between psycho-social issues, several socio-demographic and mining-related variables.

**Harassment**

Chi-Squared test of relationship established a statistically significant relationship between harassment and age (Chi-Square = 11.66, $p < 0.05$), marital status (Chi-Square = 23.08, $p < 0.05$), education level (Chi-Square = 8.90, $p < 0.05$), site of work (Chi-Square = 6.35, $p < 0.05$). A statistically significant relationship between harassment and age means that the extent to which small-scale artisanal miners are exposed to harassment or otherwise depends on their age. The results reveal that the level of harassment is more pronounced among artisanal miners who are >= 46 years old and less pronounced among artisanal miners who <= 35 years old. These results further established that artisanal miners between 36 - 45 years old are not exposed to harassment. Table 4.43 below provide detailed results of all variables whose level of relationship with harassment were found to be statistically significant at 5%.

**Bullying**

Chi-Squared test for relationship results revealed that bullying is significantly associated with artisanal mining experience (Chi-Square = 9.55, $p < 0.05$), other profession (Chi-Square = 5.72, $p < 0.05$), full-time or part-time artisanal miner (Chi-Square = 5.72, $p < 0.05$) and mining status (Chi-Square = 7.49, $p < 0.05$). A statistically significant relationship between bullying and artisanal mining experience implies that the level of experience possessed by artisanal miners play a key role in influencing the artisanal miners subjected to bullying at work. Results show that lowly experienced artisanal miners are mostly subjected to bullying than highly experienced artisanal miners. These results depict the possibility of increased levels of bullying from those who are more experienced (at least 37 months of artisanal mining experience) (see table 4.43 for detailed results).

**Subjection to any form of violence**

Tests of relationship established the existence of a statistically significant relationship between subjection to forms of violence and mining site (Chi-Square = 8.84, $p < 0.05$), age (Chi-Square = 24.10, $p < 0.05$), marital status (Chi-Square = 17.13, $p < 0.05$), other profession (Chi-Square = 10.74, $p < 0.05$), role in the family (Chi-Square = 6.07,, $p < 0.05$), full-time or part-time artisanal miner (Chi-Square = 10.74, df = 1, $p < 0.05$) and mining status (Chi-Square = 4.90, df = 1, $p < 0.05$). A relationship between violence (Yes/No) and mining site (Kwa Kitsi/Ran Mine) means that subjection of artisanal miners to forms of violence depends on location or site (Ran Mine or Kwa Kitsi Mine). For instance, results show that violence is more pronounced at Ran mine compared to Kwa Kitsi mine. These results may be of importance to law enforcement agents and other organisations who are working towards eliminating all forms of violence in areas where artisanal mining is practiced.

**Work-induced depression or stress**

Chi-Squared test of relationship established the existence of a statistically significant relationship between work-induced depression or stress and mining site (Chi-Square =

23.77, $p < 0.05$), age (Chi-Square = 19.88, $p < 0.05$), marital status (Chi-Square = 10.06, $p < 0.05$), artisanal mining experience (Chi-Square = 16.81, $p < 0.05$), educational level (Chi-Square = 12.77, $p < 0.05$), role in the family (Chi-Square = 12.30, $p < 0.05$). A statistically significant relationship implies that the extent to which artisanal miners get depressed or stressed due to work is influenced by the mining site (Ran mine or Kwa Kitsi). The results particularly show that artisanal miners from Ran mine are more prevalent to work-induced depression or stress compared to artisanal miners from Kwa Kitsi Mine.

Moreover, the results established that work-induced depression or stress was more pronounced among 26-35 years and 46-55 years and less pronounced among artisanal miners who are 18-25, 36-45 and >= 56 years of age. The results may be important for programs meant for managing depression or stress levels amongst artisanal miners. The identified most vulnerable age group of 46-55 years makes it easier to put intervention programs in place. Therefore, the result can play a key role in improving efficacy and impact of intervention programs (see table 4.43 below for a detailed list of variables that are significantly associated with work-induced depression or stress).

**Job Satisfaction**

Chi-Squared tests of relationship shows the existence of a statistically significant relationship between job satisfaction and age (Chi-Square = 54.52, $p < 0.05$), marital status (Chi-Square = 25.60, $p < 0.05$), role in the family (Chi-Square = 11.39, $p < 0.05$). The results show that the extent to which artisanal miners are satisfied with their job depends on age (youth, adult youth or adults), marital status (single, married or divorced) and associated role in the family (breadwinner or non-breadwinner). Precisely, youthful artisanal miners (18 - 35 years) are less satisfied with their job compared to those who are at least 36 years old. Furthermore, artisanal miners aged between 26 - 35 years are less satisfied with their job, which is relative to all other age groups.

**Drinking alcohol**

Chi-Squared tests of relationship showed the existence of a statistically significant relationship between drinking alcohol and mining sites (Chi-Square = 6.03, $p < 0.05$), age (Chi-Square = 41.13, $p < 0.05$), marital status (Chi-Square = 21.82, $p < 0.05$), artisanal mining experience (Chi-Square = 35.25, , $p < 0.05$) and educational level (Chi-Square = 16.22, $p < 0.05$). The relationship between drinking alcohol and mining sites imply that whether respondents are alcohol consumers depends on their mining sites; either from Ran mine or Kwa Kitsi. Ran mine has more artisanal miners who consume alcohol compared to artisanal miners from Kwa Kitsi mine. These results may also help to explain why artisanal miners from Ran mine are more exposed to forms of violence when compared to artisanal miners from Kwa Kitsi mine.

**Smoking**

Chi-Squared test of relationship established the existence of a statistically significant relationship between smoking and artisanal mining experience (Chi-Square = 17.25, $p < 0.05$). Smoking levels are high among artisanal miners with experience ranging between 13 - 36 months, and it is low among artisanal miners with 6 - 12 months, as well as those with at least 37 months of artisanal mining experience.

Table 4.43 presents Chi-Squared test statistics showing the dependent psycho-social related variables and several independent socio-demographic" and mining-related variables.

**Table 4.43: Pearson Chi-Square Test Statistics for Psycho-social related variables and socio-demographic and mining-related variables**

| Variables | Statistics | mining site | Age | Gender | Marital status | Artisanal mining experience | Educational level | Other profession | Role in the family (breadwinner or not) | Full-time or part-time artisanal miner | Mining status | Site of work |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Having suffered any harassment at work in the past 6 months | Chi-square | 0.356 | 11.657 | 1.803 | 23.079 | 6.091 | 8.901 | 0.046 | 0.640 | 0.046 | 0.031 | 6.347 |
| | Df | 1 | 4 | 1 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 2 |
| | Sig. | 0.550 | **0.020** | 0.179 | **0.000** | 0.107 | **0.031** | 0.831 | 0.424 | 0.831 | 0.861 | **0.042** |
| Being bullied at work in the past 6 months | Chi-square | 1.032 | 1.536 | 1.853 | 4.243 | 9.545 | 4.040 | 5.716 | .464 | 5.716 | 7.488 | 3.980 |
| | Df | 1 | 4 | 1 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 2 |
| | Sig. | 0.310 | 0.820 | 0.173 | 0.120 | **0.023** | 0.257 | **0.017** | 0.496 | **0.017** | **0.006** | 0.137 |
| Subjection to any form of violence | Chi-square | 8.836 | 24.898 | 0.652 | 17.132 | 7.373 | 7.787 | 10.740 | 6.072 | 10.740 | 4.897 | 0.188 |
| | Df | 1 | 4 | 1 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 2 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sig. | **0.003** | **0.000** | 0.419 | **0.000** | 0.061 | 0.051 | **0.001** | **0.014** | **0.001** | **0.027** | 0.910 |
| Culture, faith or language issues at workplace | Chi-square | 0.166 | 6.677 | 2.795 | 2.505 | 4.241 | 3.342 | 0.684 | 0.797 | 0.684 | 3.580 | 0.965 |
| | Df | 1 | 4 | 1 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 2 |
| | Sig. | 0.683 | 0.154 | 0.095 | 0.286 | 0.237 | 0.342 | 0.408 | 0.372 | 0.408 | 0.058 | 0.617 |
| Work-induced depression or stress | Chi-square | 23.763 | 19.876 | 3.009 | 10.061 | 16.805 | 12.769 | 1.334 | 12.302 | 1.334 | 2.333 | 8.393 |
| | Df | 2 | 8 | 2 | 4 | 6 | 6 | 2 | 2 | 2 | 2 | 4 |
| | Sig. | **0.000** | **0.011** | 0.222 | **0.039** | **0.010** | **0.047** | 0.513 | **0.002** | 0.513 | 0.311 | 0.078 |
| Job Satisfaction | Chi-square | 1.977 | 54.521 | 3.461 | 25.602 | 9.019 | 8.082 | 4.360 | 11.385 | 4.612 | 1.328 | 5.580 |
| | Df | 2 | 8 | 2 | 4 | 6 | 6 | 2 | 2 | 2 | 2 | 4 |
| | Sig. | 0.372 | **0.000** | 0.177 | **0.000** | 0.172 | 0.232 | 0.113 | **0.003** | 0.100 | 0.515 | 0.233 |
| drinking alcohol | Chi-square | 6.030 | 41.133 | 1.146 | 21.819 | 35.247 | 16.222 | 0.032 | 0.426 | 0.032 | 0.306 | 0.024 |
| | Df | 1 | 4 | 1 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 2 |
| | Sig. | **0.014** | **0.000** | 0.284 | **0.000** | **0.000** | **0.001** | 0.858 | 0.514 | 0.858 | 0.580 | 0.988 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Smoking | Chi-square | 2.354 | 9.253 | 1.470 | 3.874 | 17.255 | 3.030 | 3.146 | 3.053 | 3.146 | 3.258 | 4.552 |
| | Df | 1 | 4 | 1 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 2 |
| | Sig. | 0.125 | 0.055 | 0.225 | 0.144 | **0.001** | 0.387 | 0.076 | 0.081 | 0.076 | 0.071 | 0.103 |

## 4.7 MECHANICAL ISSUES

Statistical results summarizing responses gathered by the researcher on equipment related issues are presented in this section. Results on machinery use, types of machines, conditions of the machine, machine hazards, maintenance of the machines and the training of artisanal miners on how to operate the machines are presented.

### 4.7.1 Machinery use

Table 4.44 shows that majority of respondents (n = 229; 78.4%) are not using machinery while the remaining 21.6% (n = 63) used machinery. Hence, nearly 2 in every 10 artisanal miners use machinery, whilst approximately 8 in every 10 artisanal miners do not use machinery. On average, artisanal miners do not use any machinery.

**Table 4.44: Distribution of survey respondents by machinery use**

| Response | Number | Percent% |
|---|---|---|
| Yes | 63 | 22 |
| No | 229 | 78 |
| Total | 292 | 100 |

#### 4.7.1.1 Type of machines

Figure 4.7 shows that out of 63 respondents who used machinery, majority of respondents (n = 43; 68%) used air compressors, 21% (n = 13) used milling machines, 9% (n = 6) used drillers whilst the remaining 2% (n = 1) used generators. Approximately, 7 in every 10 artisanal miners use air compressors, 2 in every 10 artisanal miners use milling machines whilst the remaining 1 in every 10 use drillers. On average, artisanal miners use air compressors as their main machine.

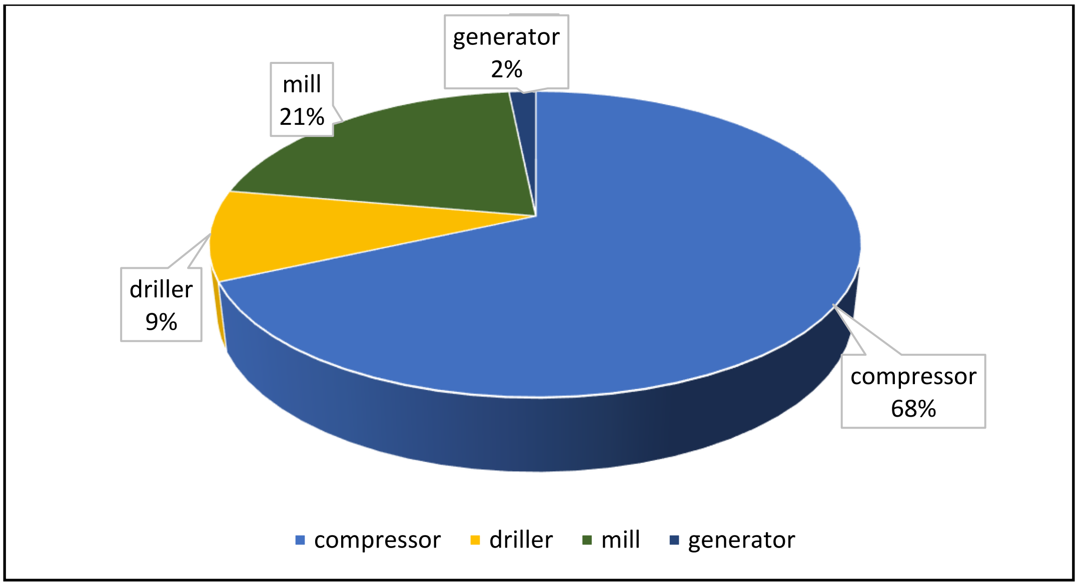



Figure 4.8: Pie chart depicting the distribution of respondents by types of machines used

#### 4.7.1.2 Training on how to operate machines

Table 4.45 shows that overwhelmingly majority of respondents (n =61; 97%) are not trained on how to use the machinery, whilst the remainder 3% (n =2) are trained on how to use the machines they operate for mining processes. Almost all artisanal miners including those who operate machines had not received training on how to use the machinery they operate. On average, artisanal miners are not trained on how to operate the machines they use for mining processes.

**Table 4.45: Distribution of respondents by whether or not training on how to operate the machine was received**

| Response | Number | Percent% |
|---|---|---|
| Yes | 2 | 3 |
| No | 61 | 97 |
| Total | 63 | 100 |

#### 4.7.1.3 Condition of machine

Table 4.46 shows that majority of respondents (n = 56; 89%) reported that their machines are in good condition whilst the remaining 11% (n = 7) reported that their machines are in bad condition. Nearly 9 in every 10 machines are in good machines whilst 1 in every 10 machines is in bad condition. Overall, machines are in good condition.

**Table 4.46: Distribution of survey respondents by condition of the machine**

| Response | Number | Percent % |
|---|---|---|
| Good | 56 | 89 |
| Bad | 7 | 11 |
| Total | 63 | 100 |

### 4.7.1.4 Maintenance of the machine

Data analysis reveals that of the 63 respondents who used machines, majority of respondents 89% (n = 56) reported that their machines are maintained, while the remaining 11% (n = 7) reported that their machines are not maintained. Hence, 9 in every 10 machines are, whilst 1 in every 10 machines are not maintained. Overall, respondents revealed that machines (air compressors, drilling machines and drillers) are being maintained.

**Table 4.47: Distribution of respondents by maintenance of the machine**

| Response | Number | Percent% |
|---|---|---|
| Yes | 56 | 89 |
| No | 7 | 11 |
| Total | 63 | 100 |

### 4.7.1.5 Machine hazards

Figure 4.8 shows that majority of respondents (n= 48; 76%) revealed that machines are associated with noise hazards, while the remaining 24% (n = 15) associated machines with vibration hazard. Overall, machines are associated with noise hazards.

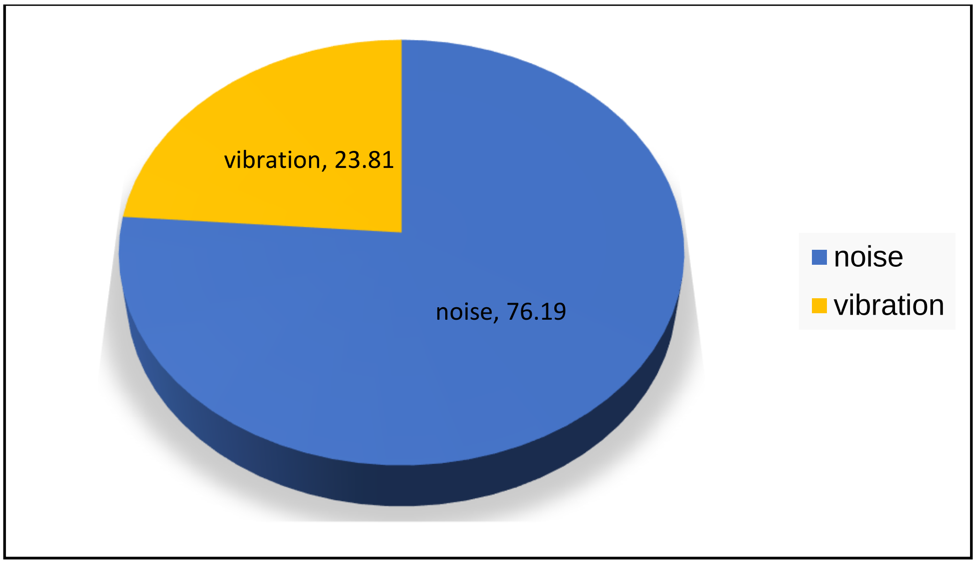



Figure 4.9: Machine hazards

#### 4.7.2 Chi-Squared Test for Relationship

Chi-Squared test of relationship results are presented in this section. Chi-Squared tests were performed to test the level of relationship between equipment-related variables and several socio-demographic and mining-related variables.

##### 4.7.2.1 Foods usually eaten

Tests of relationship were performed between food usually eaten and several socio-demographic and mining-related variables. The results show a statistically significant relationship between food usually eaten and age (Chi-Square = 28.43, $p < 0.05$), marital status (Chi-Square = 13.71, $p < 0.05$) and role of artisanal miners in the family (Chi-Square = 8.87, $p < 0.05$) (see table 4.48 and 4.49). This means that the types of food usually eaten by artisanal miners at work is influenced by age, marital status (single, married or divorced) and the role of individuals in their families (breadwinner or non-breadwinner). The results show that more artisanal miners at most 45 (<=45) years old consumed bread and milk at work compared with artisanal miners who are at least 46 years old (>=45). Artisanal miners who between the age 36 and 55 years old does not eat rice as their main meal at work. On the other hand, artisanal miners between 18 and 35 years and at least 56 years took rice as their main meal at work. Artisanal miners whose age is between 46 and 55 years old consumed *sadza* (thick porridge) and meat more than any other age group. Interestingly, this result reveals that artisanal miners who are most likely to perform heavy manual tasks (<=45 years old) turns out to be the same cohort that rely on bread and milk for their main meals.

This might expose artisanal miners to nutritional risks which may in turn weigh heavily against their physical well-being.

#### 4.7.2.2 Type or Design of Machinery

Chi-Squared results showed that a statistically significant relationship exist between type or design of machines and educational level (Chi-Square = 19.25, $p < 0.05$), other profession (Chi-Square = 17.93, $p < 0.05$), full-time or part-time artisanal miner (Chi-Square = 17.93, $p < 0.05$), mining status (Chi-Square = 11.33, $p < 0.05$) (see table 4.49 and 4.49). These results imply that design or make of machines used by respondents is determined by their level of education, whether or not they had other professions and their employment status with their respective mines (full-time or part-time and/or self-employed or labourers). The results particularly show that artisanal miners who use compressors decrease as the level of education increases. There are more uneducated artisanal miners who use compressors compared to artisanal miners with tertiary education. Therefore, intervention / awareness programs aimed at minimizing the risks from machinery use such as vibrations should target the uneducated artisanal miners more than educated artisanal miners.

#### 4.7.2.3 Condition of the machine

Chi-Squared test results revealed that statistically significant relationship exist between machine condition (good/bad) and gender (Chi-Square = 4.82, $p < 0.05$), marital status (Chi-Square = 10.26, $p < 0.05$), artisanal mining experience (Chi-Square = 9.54, $p < 0.05$) (refer to tables 4.50 and 4.49). This, therefore, implies that the condition of the machine depends on the respondents' gender (male or female), their marital status (single, married or divorced) and their level of mining experience (years). The results show that there are more male artisanal miners who rated the condition of machines as good compared to female artisanal miners (and vice versa). Theses result might point to the need for mine owners to have clearly designed templates to determine the condition of machines to eliminate the role of gender when determining the condition of machines. This helps to eliminate inappropriate equipment which bears the potential to pose health risks for small-scale artisanal miners.

#### 4.7.2.4 Machine maintenance

Chi-Squared test of relationship was used to show that a statistically significant relationship exists between machine maintenance and gender (Chi-Square = 4.82, $p < 0.05$) (refer to tables 4.51 and 4.49). This means that the extent to which machines are maintained depends on whether the respondent is male or female. These results show that more males believe that machines are being maintained than females. These results can be used for planning, design and implementation of intervention strategies aimed at ensuring that machine operators receive comprehensive training on how to use and maintain the machines. Knowledge acquisition can help minimize artisanal miners' risk of exposure to health risks associated with the use inappropriate equipment.

#### 4.7.2.5 Type of mechanical hazards

Tests of relationship revealed that type of machine hazards are significantly related with gender (Chi-Square = 5.670, $p < 0.05$), marital status (Chi-Square = 7.480, $p < 0.05$) and mining status (Chi-Square = 9.460, $p < 0.05$) (refer to tables 4.52 and 4.49). Therefore, the types of machine hazards depend on respondents' gender (male or female), marital status (single, married or divorced) and employment status (self-employed or a labourer). The results, as presented in table 4.53, show that more males than females are exposed to noise hazards caused by machines. On the other hand, more females than males are exposed to vibrating machine hazards. Noise hazards are mostly common among single and married artisanal miners compared to the divorced artisanal miners. Vibrating machine hazards are mostly common among divorced artisanal miners compared to single or married artisanal miners. Moreover, noise machine hazards are mostly common among artisanal miners who are self-employed compared to labourers. On the other hand, vibrating machine hazards are mostly experienced by labourers compared to self-employed artisanal miners.

**Table 4.53: Pearson Chi-Square Test Statistics for Equipment issues and socio-demographic and mining-related variables**

| Variable | Category | Mention 3 foods that you usually eat here | | | Type of machinery | | | | Condition of the machine | | Machine maintenance | | Machine hazard | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | bread and drink | sadza and meat | Rice | compressor | driller | miller | generator | Good | Bad | yes | no | noise | vibration |
| Mining site | Kwa Kitsi | 67.2% | 25.5% | 7.3% | 70.0% | 5.0% | 22.5% | 2.5% | 87.5% | 12.5% | 87.5% | 12.5% | 75.0% | 25.0% |
| | Ran mine | 71.0% | 21.0% | 8.0% | 65.2% | 17.4% | 17.4% | 0.0% | 91.3% | 8.7% | 91.3% | 8.7% | 78.3% | 21.7% |
| Age | 18 -25 years | 71.2% | 27.4% | 1.4% | 73.3% | 13.3% | 13.3% | 0.0% | 93.3% | 6.7% | 100.0% | 0.0% | 80.0% | 20.0% |
| | 26 -35 years | 70.8% | 19.0% | 10.2% | 64.5% | 9.7% | 22.6% | 3.2% | 93.5% | 6.5% | 87.1% | 12.9% | 83.9% | 16.1% |
| | 36 -45 years | 75.0% | 25.0% | 0.0% | 50.0% | 16.7% | 33.3% | 0.0% | 83.3% | 16.7% | 83.3% | 16.7% | 66.7% | 33.3% |
| | 46 -55 years | 54.5% | 45.5% | 0.0% | 100.0% | 0.0% | 0.0% | 0.0% | 100.0% | 0.0% | 75.0% | 25.0% | 75.0% | 25.0% |
| | 56 years and above | 53.6% | 21.4% | 25.0% | 71.4% | 0.0% | 28.6% | 0.0% | 57.1% | 42.9% | 85.7% | 14.3% | 42.9% | 57.1% |
| Gender | Male | 66.8% | 24.8% | 8.4% | 60.4% | 10.4% | 27.1% | 2.1% | 93.8% | 6.3% | 93.8% | 6.3% | 83.3% | 16.7% |
| | Female | 72.2% | 22.2% | 5.6% | 93.3% | 6.7% | 0.0% | 0.0% | 73.3% | 26.7% | 73.3% | 26.7% | 53.3% | 46.7% |
| Marital status | Single | 66.0% | 34.0% | 0.0% | 70.0% | 20.0% | 10.0% | 0.0% | 90.0% | 10.0% | 100.0% | 0.0% | 70.0% | 30.0% |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Married | 68.4% | 23.1% | 8.4% | 68.1% | 8.5% | 21.3% | 2.1% | 93.6% | 6.4% | 87.2% | 12.8% | 83.0% | 17.0% |
| | Divorced | 78.6% | 0.0% | 21.4% | 66.7% | 0.0% | 33.3% | 0.0% | 50.0% | 50.0% | 83.3% | 16.7% | 33.3% | 66.7% |
| artisanal mining experience | 6months – 1year | 70.7% | 19.0% | 10.3% | 50.0% | 33.3% | 16.7% | 0.0% | 100.0% | 0.0% | 100.0% | 0.0% | 66.7% | 33.3% |
| | 13months – 2years | 77.8% | 20.8% | 1.4% | 76.5% | 5.9% | 17.6% | 0.0% | 100.0% | 0.0% | 94.1% | 5.9% | 82.4% | 17.6% |
| | 25months – 3years | 62.2% | 24.4% | 13.3% | 83.3% | 0.0% | 16.7% | 0.0% | 91.7% | 8.3% | 91.7% | 8.3% | 100.0% | 0.0% |
| | 37months and above | 64.1% | 28.2% | 7.7% | 63.6% | 4.5% | 27.3% | 4.5% | 72.7% | 27.3% | 77.3% | 22.7% | 63.6% | 36.4% |
| Educational level | None | 70.0% | 17.5% | 12.5% | 85.7% | 0.0% | 14.3% | 0.0% | 100.0% | 0.0% | 100.0% | 0.0% | 100.0% | 0.0% |
| | Primary | 65.1% | 24.1% | 10.8% | 70.6% | 0.0% | 29.4% | 0.0% | 88.2% | 11.8% | 88.2% | 11.8% | 76.5% | 23.5% |
| | Secondary | 68.5% | 27.3% | 4.2% | 67.6% | 8.8% | 20.6% | 2.9% | 85.3% | 14.7% | 85.3% | 14.7% | 76.5% | 23.5% |
| | Tertiary | 76.9% | 15.4% | 7.7% | 40.0% | 60.0% | 0.0% | 0.0% | 100.0% | 0.0% | 100.0% | 0.0% | 40.0% | 60.0% |
| Other profession | Yes | 70.4% | 23.9% | 5.6% | 54.5% | 36.4% | 0.0% | 9.1% | 100.0% | 0.0% | 90.9% | 9.1% | 54.5% | 45.5% |
| | No | 67.9% | 24.0% | 8.1% | 71.2% | 3.8% | 25.0% | 0.0% | 86.5% | 13.5% | 88.5% | 11.5% | 80.8% | 19.2% |
| Role in the | Yes | 69.5% | 21.3% | 9.2% | 68.5% | 7.4% | 22.2% | 1.9% | 88.9% | 11.1% | 87.0% | 13.0% | 75.9% | 24.1% |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| family (breadwinner or not) | No | 64.2% | 35.8% | 0.0% | 66.7% | 22.2% | 11.1% | 0.0% | 88.9% | 11.1% | 100.0% | 0.0% | 77.8% | 22.2% |
| Full-time or part-time artisanal miner | full-time | 67.9% | 24.0% | 8.1% | 71.2% | 3.8% | 25.0% | 0.0% | 86.5% | 13.5% | 88.5% | 11.5% | 80.8% | 19.2% |
| | part-time | 70.4% | 23.9% | 5.6% | 54.5% | 36.4% | 0.0% | 9.1% | 100.0% | 0.0% | 90.9% | 9.1% | 54.5% | 45.5% |
| Mining status | self-employed | 69.9% | 24.1% | 6.0% | 70.8% | 4.2% | 25.0% | 0.0% | 85.4% | 14.6% | 89.6% | 10.4% | 85.4% | 14.6% |
| | Labourer | 64.5% | 23.7% | 11.8% | 60.0% | 26.7% | 6.7% | 6.7% | 100.0% | 0.0% | 86.7% | 13.3% | 46.7% | 53.3% |
| Site of work | Underground | 64.7% | 35.3% | 0.0% | 50.0% | 0.0% | 50.0% | 0.0% | 50.0% | 50.0% | 100.0% | 0.0% | 100.0% | 0.0% |
| | above ground | 71.9% | 18.8% | 9.4% | 66.7% | 11.1% | 22.2% | 0.0% | 88.9% | 11.1% | 88.9% | 11.1% | 77.8% | 22.2% |
| | Both | 68.3% | 23.9% | 7.8% | 69.2% | 9.6% | 19.2% | 1.9% | 90.4% | 9.6% | 88.5% | 11.5% | 75.0% | 25.0% |

**Table 4.54: Pearson Chi-Square Tests**

| Variables | | mining site | Age | Gender | Marital status | Artisanal mining experience | Educational level | Other profession | Role in the family (breadwinner or not) | full-time or part-time artisanal miner | Mining status | Site of work |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mention 3 foods that you usually eat here? | Chi-square | 0.744 | 28.425 | 1.106 | 13.714 | 9.545 | 7.207 | 0.501 | 8.867 | 0.501 | 2.777 | 2.815 |
| | Df | 2 | 8 | 2 | 4 | 6 | 6 | 2 | 2 | 2 | 2 | 4 |
| | Sig. | 0.689 | **0.000** | 0.575 | **0.008** | 0.145 | 0.302 | 0.779 | **0.012** | 0.779 | 0.250 | 0.589 |
| Do you have any machinery? | Chi-square | 0.182 | 0.630 | 1.853 | 4.040 | 1.424 | 0.945 | 2.051 | 0.808 | 2.051 | 0.205 | 1.783 |
| | Df | 1 | 4 | 1 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 2 |
| | Sig. | 0.669 | 0.960 | 0.173 | 0.133 | 0.700 | 0.815 | 0.152 | 0.369 | 0.152 | 0.651 | 0.410 |
| If yes what is the design of the machinery? | Chi-square | 3.163 | 5.597 | 6.358 | 3.148 | 12.907 | 19.248 | 17.925 | 2.410 | 17.925 | 11.333 | 1.431 |
| | Df | 3 | 12 | 3 | 6 | 9 | 9 | 3 | 3 | 3 | 3 | 6 |
| | Sig. | 0.367 | 0.935 | 0.095 | 0.790 | 0.167 | **0.023** | **0.000** | 0.492 | **0.000** | **0.010** | 0.964 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Has training been provided on how to use the machinery? | Chi-square | 3.592 | 4.406 | 0.645 | 0.703 | 3.849 | 4.496 | 0.437 | 0.344 | 0.437 | 0.645 | 2.175 |
| | Df | 1 | 4 | 1 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 2 |
| | Sig. | 0.058 | 0.354 | 0.422 | 0.704 | 0.278 | 0.213 | 0.509 | 0.557 | 0.509 | 0.422 | 0.337 |
| What is the condition of the machine? | Chi-square | 0.214 | 8.812 | 4.823 | 10.264 | 9.537 | 1.952 | 1.666 | .000 | 1.666 | 2.461 | 3.180 |
| | Df | 1 | 4 | 1 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 2 |
| | Sig. | 0.644 | 0.066 | **0.028** | **0.006** | **0.023** | 0.582 | 0.197 | 1.000 | 0.197 | 0.117 | 0.204 |
| Is the machine being maintained? | Chi-square | 0.214 | 3.016 | 4.823 | 1.568 | 5.070 | 1.952 | 0.055 | 1.313 | 0.055 | 0.098 | 0.260 |
| | Df | 1 | 4 | 1 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 2 |
| | Sig. | 0.644 | 0.555 | **0.028** | 0.457 | 0.167 | 0.582 | 0.814 | 0.252 | 0.814 | 0.754 | 0.878 |
| Is the machine associated with any hazard? | Chi-square | 0.086 | 5.719 | 5.670 | 7.480 | 6.617 | 5.800 | 3.442 | 0.015 | 3.442 | 9.460 | 0.678 |
| | Df | 1 | 4 | 1 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 2 |
| | Sig. | 0.770 | 0.221 | **0.017** | **0.024** | 0.085 | 0.122 | 0.064 | 0.904 | 0.064 | **0.002** | 0.712 |

## 4.8 CONCLUSION

The purpose of this chapter was to analyse data, present and report results. Descriptive statistics, frequency tables and graphs were used to describe the survey data. Data was analysed, presented and reported on six key occupational health areas which are considered in this study namely; (1) physical health risks, (2) ergonomic issues, (3) occupational health problems, (4) chemical agents, (5) psychosocial issues and (6) equipment issues. Chi-Squared test or cross-tabulations were used to identify independent socio-demographic and mining-related variables of statistical significance to dependent variables related to physical health risks, ergonomic issues, incidences of occupational health problems, chemical agents, psychosocial issues and equipment as well as machinery issues. The next chapter will discuss the research findings of the study.

## CHAPTER FIVE

## DISCUSSION OF FINDINGS

### 5.1 INTRODUCTION

The preceding chapter presented and reported research results with the aid of descriptive statistics, frequency tables, graphs and chi-squared statistical technique for testing relationship between variables. The purpose of this chapter is to discuss the research findings. The results will be discussed under: Physical health risks, ergonomic issues, occupational health incidences, Chemical health risks, Psychosocial issues and equipment issues.

### 5.2PHYSICAL HEALTH RISKS

The research findings established that there is an array of physical health risks associated with artisanal and small-scale gold mining. The artisanal gold miners dig small tunnels, and, in the tunnels, most respondents reported that there is inadequate space to move around and they cannot work freely. The artisanal miners also indicated that there is inappropriate temperature regulation and inappropriate ventilation. These unfavourable working conditions leave the artisanal miners highly susceptible to extreme temperatures and inadequate air supply particularly those who work underground.

The findings of this study are supported by the work of other authors on the similar subject. These results are supported by an article (true scale of artisanal mining) which states that artisanal miners who work underground are exposed to health risks such as; heat, noise, confusion, darkness, foul air, and unbearably cramped space, (Burki 2019). These results are supported by (Jerie, 2013) who indicated that there is lack of appropriate temperature regulations in artisanal mining. According to the research findings the lack of temperature regulation is extreme for artisanal miners from Kwa Kitsi, which is relative to artisanal miners from Ran Mine. According to WHO (2016), the labour-intensive nature of ASGM can be compounded by extremely hot and humid working conditions.

### 5.3 ERGONOMIC ISSUES

The findings indicated that artisanal mining pose a discomfort to the wellbeing of artisanal miner. Most miners work long hours, working 7 to 8 hours a day in such a labour-intensive environment is detrimental to the wellbeing of artisanal miners. A considerable number of artisanal miners indicated that the mining process involves labour intensive activities such as carrying sacks, digging with picks and shovels, carrying water and crushing of stones. The artisanal miners from both mines usually spend 3hours standing statistic in one position. The level of relationship established between pain or discomfort and mining site implies that pain or discomfort endured by artisanal miners depends on their location or area; whether the artisanal miner works at Ran mine or Kwa Kitsi. In particular, the results revealed that artisanal miners from Kwa Kitsi endures more pain or discomfort on necks, shoulders, wrists, lower backs due to their jobs, which is relative to artisanal miners from Ran mine. On the other hand, artisanal miners from Ran mine endure more pain or discomfort on upper backs due to their jobs and it is relative to artisanal miners from Kwa Kitsi. These results help with planning, designing, implementing pain relief processes, management strategies and/or programs as well as properly targeting the interventions for efficiency, effectiveness and impact.

The number of working hours reported in this study supports Hentschel, Hruschka, & Priester, (2002) in their global report on Artisanal and Small-Scale Mining. A study conducted in India found that working with static posture over the longer duration has a significant relationship with the lower back disorder (with $p = 0.020$) and bouncing and jarring has also significantly associated with the lower back disorder (Jeripotula, Mangalpady & Mandela 2020).

## 5.4 INCIDENCES OCCUPATIONAL HEALTH PROBLEMS

The findings of the study revealed that work-related injuries were common amongst artisanal miners from both mining sites. The results also indicated that some injuries were caused by dog bite while the miners were running from the police. Some fatalities were extreme mine collapses which lead to death. Artisanal miner reported that they experience work related pain and discomfort on their lower back, upper back, wrist, shoulders and neck.

Findings of this study are similar to the findings of Fadlallah, Pal & Hoe (2020) in their study conducted in Sudan reported that artisanal miners were persistently exposed to accidents and fatal injuries. An analysis of injury claims of eight mining companies in the USA during the period 1996-2008, related to miners engaged in low-seam coal mines, revealed that the knee was the most affected body part followed by the lower back (Gallagher, Moore, & Dempsey, (2009)). The findings from this study differ from Gallagher *et al.*, (2009) because in this case upper and lower back are the most affected body parts among artisanal miners from Ran and KwaKitsi mine. More specifically, artisanal miners from Kwa Kitsi mostly suffer from necks, shoulders, wrists and lower backs compared to artisanal miners from Ran mine. Furthermore, artisanal miners from Ran mine felt more pain or discomfort on their upper backs due to their job compared to artisanal miners from Kwa Kitsi mine.

Results from a study conducted in Cameroon also indicated that the major causes of death amongst artisanal miners were; collapse of galleries (65.8%), subsidence (31.6%) and others (2.6%) like bad communication with working equipment and drowning in water-logged pits, (Ralph *et al,* 2018)

**5.5 CHEMICAL HEALTH RISKS**

The findings of the study show that a large number of artisanal miners are exposed to mercury and a lesser number is exposed to cyanide and lime. These chemicals and other toxic gases which the artisanal miners are exposed to may have long and short-term adverse effects on their normal physical and mental functioning. Mining processes allow chemicals to be mixed. Surprisingly, the results showed that small-scale artisanal miners do not wear personal protective clothing (PPEs) when handling or mixing these chemicals. In this study the extent of exposure could not be determined since no blood samples were taken.

These results in the study are supported by the World Health Organisation article which indicates that most common chemical exposures in ASGM which constitutes mercury (used to amalgamate the gold) and cyanide (used to extract gold from tailings) (WHO, 2016).

The results relate to the findings of a study a study conducted in Kadoma; Zimbabwe indicated that about 90% of the respondent used mercury in the mining process however most of the respondent did not present any health symptoms related to mercury exposure. Human blood samples where not collected hence the extent of the exposure could not be determined, (Becker, Bose-O'Reilly, Shoko, Singo & Steckling 2020). A study conducted in Nigeria supported that there are potential health risks of toxic metals associated with artisanal mining contamination, (Laniyan & Adewumi 2020). The findings of the study with regards to wearing of PPE's is supported by the findings of Afrifa, Opoku, Gyamerah, Ashiagbor & Sorkpor (2019) who reported that among ASGMs reveal an insignificant to a non-existent PPE compliance. For instance, among ASGMs in Ghana, Afrifa et al. (2019) found that about 86.55% of their study participants exhibited absolute non-compliance for appropriate use of protective clothing or equipment. Specifically, 89.8% non-compliance in the use of nose mask for protection against vaporous mercury was reported. Maia, (2018) in Indonesia did not find anyone wearing PPE's when they conducted an assessment.

**5.6 PSYCHO-SOCIAL ISSUES**

Alcohol consumption and smoking was prevalent amongst artisanal miners in this study. This was followed by violence which was more pronounced at ran mine than Kwa kitsi.

Bullying and artisanal mining experience are significantly associated. Less experienced artisanal miners are frequently bullied compared to highly experienced artisanal miners. Findings indicated that 74% of artisanal miners suffered from depression and stress due to work at some point in time. Results indicate that miners are dissatisfied with their job, where an overwhelming majority (80%) registered their dissatisfaction.

The findings of this study are supported by Ajith &Ghosh (2019) who reported that job dissatisfaction and job-related stress were the found to be main contributing risk factors for the likelihood and severity of injuries amongst artisanal and small scale gold miners.

Results about work related violence differ from the findings of a study conducted in the DRC which indicated that women living near ASM are indeed more likely to experience sexual violence of both types, although the effect is stronger for non-partner sexual violence (Rustad, Østby & Nordås, 2016). The findings relate to the results of a study conducted in Cameroon in which, the prevalence of alcohol consumption and cigarette smoking amongst miners was 86.2% and 41.4% respectively. The mean quantity of alcohol consumed per week was 13.64 ± 19.65 bottles, (Ralph *et al*. 2018)

**5.7 MECHANICAL ISSUES**

Most artisanal miners in the study did not use any machinery. The results indicated that 78% of artisanal miners do not use machinery. A small percentage of those who used machinery never received any occupational health training on the use of machinery. Artisanal miners are not trained to use the machines they mainly use to perform their work. The machines used by artisanal gold miners in the study exposed them to hazards such as vibration and noise. Due to lack of training on the use of the machines the artisanal miners are susceptible to machine related injuries. Lack of training also present a major physical health risk to machine operators as it signifies lack of pre-requisite knowledge required from operators in order to ensure that they operate the machines within the confines of health and safety measures

The lack of machinery use in artisanal mining is supported by Schwartz et al (2021), who indicated that the absence of mechanization, long working hours, and extremely hazardous workplaces create biomechanical problems, caused by accidents, lifting, lugging, digging, and falling. The lack of occupational health training is supported by findings of the study on Risk Factors for the Number of Sustained Injuries in Artisanal and Small-Scale Mining Operation conducted in Kenya in which in which the respondents agreed that lack of health and safety training put them at high risk of injuries, as revealed by a mean score of 3.54 in both the injured and uninjured category (Ajith, Ghosh & Jansz 2020).

## 5.8 CONCLUSION

The purpose of this chapter was to highlight and discuss major research findings. Precisely, the chapter carried out discussions on the findings established around the 6 key occupational health and safety areas which formed the epicentre for this research. The discussion shows that most of the findings are supported by the work of previous authors. The next chapter will provide a summary and implications, conclusions, recommendations and limitations of the study.

## CHAPTER SIX

## SUMMARY, CONCLUSION AND RECOMMENDATIONS

### 6.1 INTRODUCTION

This is the final chapter and it consists of the summary and implications, limitations, recommendations and conclusion, based on the study results. This is based on the study results that are presented in chapter four and discussion in chapter 5.

### 6.2 SUMMARY AND IMPLICATIONS OF THE RFINDINGS

Stress or depression among artisanal miners due to work is most prevalent. These results bear a very strong implication because it requires further research, for instance, research studies to identify the main causes of stress or depression among artisanal miners. Specifically, Beck's Depression Inventory scores could be used to help ascertain the severity of depression or stress experienced by artisanal gold miners. The results may also be used to properly target intervention programs which are mainly designed and implemented to manage depression or stress levels among artisanal miners, hence, contributing to high efficacy and impact levels of such intervention programs.

The findings of this study provided evidence supporting high job dissatisfaction levels among artisanal miners. Apart from revealing that artisanal miners were dissatisfied with their work, the study identified age groups that were highly dissatisfied with their job. These results provide the basis for planning, designing and implementing intervention programs and/or strategies to motivate artisanal miners.

The findings led to the identification of gaps in training, for instance, artisanal miners lacked training on how to operate machinery used during mining. The finding reaffirms the need for training among artisanal small-scale miners. Properly trained people result in improved efficiency, hence, increased productivity.

Another important finding which culminated from this study is on the condition of the machines and gender, which are significantly associated. Since the ratings can be more subjective, the findings show a need for further research with the objective to establish the nature of relationship between the two variables.

From the findings of this study, the risk of exposure to noise hazards is high among male artisanal miners, while the risk of exposure to vibration hazards is more prevalent among female artisanal miners. These results create opportunities for designing and implementing effective occupational risk management strategies.

## 6.2 LIMITATIONS OF THE RESEARCH RESULTS

The study successfully in addressed the goals that the research was intended to, however, the study was without its own limitations. The first limitation relates to the sample size used. For instance, the sample size of 292 artisanal miners was too small to perform multi-layered variable analysis. For instance, it would have been more useful to cross-tabulate the dependent variable against several of independent socio-demographic and mining-related variables. For instance, instead of testing the level of relationship between two variables alone, we would have enriched the findings of this study by examining joint influence of 2 or more independent variables on the dependent variable. The researcher failed to pursue this direction because it could have led to the derivation of unreliable chi-squared test results due to the violation of the assumptions underlying the statistical technique.

The second limitation of this study relates to the methods employed by the researcher in addressing the research questions. This study used descriptive statistics, frequency tables, graphs and Chi-Squared test to describe and understand internal patterns, trends and relationships hidden within the gathered survey data. Despite being enough for the cause at hand, the researcher feels that advanced statistical methods could have been employed to subject the data to more statistical rigor. Such methods involve binary logistic regression (for binary variables), test for equality of means, Kruskal Wallis test etc.

## 6.4 RECOMMENDATIONS

Based on the findings reached by this study, the researcher would like to make the following recommendations:

1. The researcher recommends that there is an urgent need for research on comprehensive occupational health programs aimed at addressing the array of hazards faced by artisanal and small-scale miners.
2. The researcher recommends that qualitative research on the same study should be carried out as this will help to explore more on occupational health risks amongst artisanal and small-scale gold miners. This will enable researchers to carry out some in-depth interviews and probe more on issues of occupational health and safety.
3. The researcher recommends that the same nature of research should be done but not in a comparative manner because comparing the two mines might end up making the researcher focus more on comparison instead of understanding the real occupational health and safety issues on the ground.

4. The researcher recommends mining representatives to consider formalising artisanal and small-scale mining, improving working conditions through imposing safety standards and rolling out access to health care.

**6.5 CONCLUSIONS**

The findings of this study were successful in addressing the goals that the research was set out to achieve. The following conclusions were made from the present study: the researcher concluded that many artisanal miners did not wear PPE’s when handling mercury and thus exposing them to mercury vapour. Based on the psychosocial health risks findings the researcher concluded that there was high alcohol consumption amongst artisanal miners, and it was related to violent behaviour. The researcher concluded that artisanal mining is labour intensive, and most miners work long hours. The working conditions are highly unfavourable for those working underground in poorly supported tunnels with poor ventilation and unregulated temperatures. Based on the findings of the study the researcher concluded that there were high levels of stress and depression amongst artisanal miner. The study findings indicated that there were high levels of job dissatisfaction amongst artisanal gold miners. The study concluded that Artisanal miners are susceptible to work-related injuries because of the nature of their operations.

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## APPENDIX A: ETHICAL CLEARANCE

RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER/INVESTIGATOR:

**Mr MT Matemera**

**Student No:**
**11626918**

PROJECT TITLE: **Occupational Health Risk amongst Artisanal and Small-Scale Gold Miners in Bindura Town, Zimbabwe.**

PROJECT NO: **SHS/18/PH/37/0402**

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

| NAME | INSTITUTION & DEPARTMENT | ROLE |
|---|---|---|
| Dr NS Mashau | University of Venda | Supervisor |
| Mr BS Manganye | University of Venda | Co - Supervisor |
| Mr MT Matemera | University of Venda | Investigator – Student |

ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE

Date Considered: February 2019
Decision by Ethical Clearance Committee Granted
Signature of Chairperson of the Committee: ..........................................
Name of the Chairperson of the Committee: Senior Prof. G.E. Ekosse

UNIVERSITY OF VENDA
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**APPENDIX B: QUESTIONNAIRE**

**Occupational health risks amongst artisanal gold miners in Bindura Zimbabwe**

**Instructions:** Please read and answer all questions below, you can choose an answer from the options given or you can fill in your answer in the provided space.

**Respondent code**

Mining site: Ran Mine [ ] Kwa Kitsi Mine []

**SECTION A: DEMOGRAPHIC VARIABLES**

1. Age (tick your age)
1. 18-25 years [ ] 2. 26-35 years [ ] 3. 36-45 years [ ]
4. 46-55 years [ ] 5. 56 years and above [ ]
2. What is your Gender? Male [ ] Female [ ]
3. Marital status Single [ ] Married [ ] Divorced [ ] Other [ ]
4. For how long have you been in artisanal mining?
1. 6months – 1year [ ] 2. 13months – 2years [ ]
3. 25months – 3years [ ] 4. 37months and above [ ]
5. Highest educational level?
1.None [ ] 2. Primary [ ] 3. Secondary [ ] 4. Tertiary [ ]

6. What is your profession? State below

7. Are you a breadwinner in the family? 1. yes [ ] 2. No [ ]

8. Do you do artisanal mining full time or as part time job? 1. Full-time [ ] 2. Part-time [ ]
9. Mining status: 1. Self-employed [ ] 2. Labourer [ ]
10. Site of work:
1. underground [ ] 2. Above ground [ ] 3. Both [ ]

**SECTION B: PHYSICAL HEALTH RISKS**

| QN | QUESTION | 1. Yes | 2. No | 3. Not sure |
|---|---|---|---|---|
| 11. | Is there adequate ventilation at workplace? | | | |
| 12. | Do you have appropriate temperature regulation? | | | |
| 13. | Do you have enough workspace? | | | |
| 14. | Do you have enough physical space to move while working? | | | |

15 How many hours do you work per day? (Please tick)

1-2hrs [ ] 3-4hrs [ ] 5-6hrs [ ] 7-8hrs [ ] Above 8hrs [ ]

16. Do you carryout heavy manual tasks 1. Yes [ ] 2. No [ ]
16a). If yes which heavy tasks (mention below)

________________________________________________________________

________________________________________________________________

17. Do you have to remain in static position for a long period? 1. Yes [ ] 2. No [ ]

17a. If yes, for how long?
1hr [ ] 2hrs [ ] 3hrs [ ] 4hrs and above [ ]
18. Do you wear any protective clothing? 1. Yes [ ]2. No [ ]

18a). If yes which protective clothing do you wear?
1. ________________________

2. ______________________

3. ______________________

4. ______________________

19. Have you been injured at work in the past 6 months? 1. Yes [ ] 2. No [ ]

19a).If yes what caused the injury.

____________________________________________________________________________
____________________________________________________________________________

20. In the last year, have you had pain or discomfort caused by your job that lasted 2 days or more?

1. Yes [ ] 2. No [ ]

If yes, please specify the body part where pain is felt
1. Neck [ ] 2. Shoulder [ ] 3. Elbow [ ] 4. Wrist [ ] 5. Hand [ ]
6. Upper back [ ] 7. Lower back [ ] 8. Foot [ ]

21. While working is the pain or discomfort:
1. less [ ] 2. same [ ] 3. Worse [ ]

22. After work, is the pain or discomfort?
1. less [ ] 2. same [ ] 3. Worse [ ]

23. After a week away from work is the pain or discomfort:
1. less [ ] 2. same [ ] 3. Worse [ ]
24. Has the pain or discomfort caused you to take time off work in the past six months?

1. Yes [ ] 2. No [ ]

24a)If yes, how many days off in all? _____ Days

25. To what degree has your pain or discomfort interfered with your work, your life outside of work, and your sleep in the past 6 months?

25.1. How much does it interfere with your work?

1. No interference [ ] 2. Some interference [ ]

3. Had to take time off work due to pain [ ]

25.1a)If you had to take time off work, how many days off in the past 6 months? _____

25.2. How much does the pain or discomfort interfere with your life outside of work?

1. No interference [ ] 2. Some interference [ ]

3. Had to stop enjoying activity due to pain [ ]

25.2a)If you had to stop activity, how many days in the past 6 months did you stop it? _____

25.3. How much does the pain or discomfort interfere with your sleep?

1. No interference [ ] 2. Some interference [ ] 3. It affects me every night [ ]

26. Do you experience any other health problems related to your work?

1. Yes [ ]  2. No [ ]

26a). If yes, please describe:

___

___

**SECTIONS C: CHEMICAL HEALTH RISKS**

27. Are workers exposed to chemicals that could affect their normal physical or mental functioning in short or long term? Yes [ ] No [ ]

27a. If yes which chemicals are being used?

1. ____
2. ____
3. ____
4. ____

28. Is there extraction of any potentially harmful gases. Yes [ ] No [ ]

28a). If yes which gases

5. ____
6. ____
7. ____
8. ____

29. Does the process allow the chemicals to be mixed? Yes [ ] No [ ]

30. Do you use any personal protective equipment when handling chemicals?

Yes [ ]  No [ ]

31. Do you inhale dust particles in any of the process? Yes [ ] No [ ]

32 Do u have any facilities for washing hands after using chemicals?

Yes [ ]  No [ ]

**SECTION D: PSYCHOSOCIAL HEALTH RISKS**

| QN | STATEMENT | 1. YES | 2. NO | 3. not sure |
|---|---|---|---|---|
| 33. | Have you suffered any harassment at work in the past 6 months? | | | |
| 34. | Have you ever been bullied at work in the past 6 months? | | | |
| 35. | Have u been subjected to any form of violence? | | | |
| 36. | Are there any culture, faith or language issues at the site? | | | |
| 37. | Are there systems in place for workers to pass on issues and complains? | | | |
| 38. | Are the systems being used? | | | |
| 39. | Does work take you away from family and friends? | | | |
| 40. | Do you feel depressed or stressed because of your job? | | | |
| 41. | Are you satisfied with your Job? | | | |
| 42. | Do you drink alcohol? | | | |
| 43. | Do you smoke? | | | |

44. Mention three foods that you usually eat here:

1. ______________________ 2 ________________________ 3 __________________

**SECTION E: MECHANICAL HEALTH RISKS**

45. Do you use any machinery? Yes [ ] No [ ]

46. If yes what is the design of the machinery?

________________________________________________________________________

________________________________________________________________________

47. Has training been provided on how to use the machinery? Yes [ ] No [ ]

47. Has training been provided on how to use the machinery? Yes [ ] No [ ]

48. What is the condition of the machine? Good [ ] Bad [ ]

49. Is the machine being maintained? Yes [ ] No [ ]

50. Is the machine associated with any hazard below? (Please tick)

1. Noise [ ] 2. Vibration [ ] 3. Heat [ ] 4. Radiation [ ] 5. Exhaust emissions [ ]

6. others [ ]

If other specify?

________________________________________________________________________

________________________________________________________________________