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RISK FACTORS OF OCCUPATIONAL FATIGUE AMONG WORKERS AT ANGLOGOLD ASHANTI IDUAPRIEM MINE, TARKWA

BY

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DECLARATION

Except for the researches of others that have been duly acknowledged, I, Isaac Owusu Anyimah, declare that this work is the result of my own original research, and that this dissertation, in whole or in part, has not been presented elsewhere for another degree.

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LIST OF ABBREVIATIONS

AAC	American Addiction Centers
AAIL	AngloGold Ashanti Iduapriem mine Limited
CFS	Chalder Fatigue Scale
CIL	Carbon in-leaching
CNS	Central Nervous System
EEG	Electroencephalography
4DSQ	Four-Dimensional Symptom Questionnaire
WHO	World Health Organization
GSS	Ghana Statistical Service
HSE	Health Safety and Environment
CFQ	Chalder Fatigue Scale
FAS	Fatigue Assessment Scale
CIS	Check List Individual Strength
SOFI	Swedish Occupational Fatigue Inventory
OFER	Occupational Fatigue Exhaustion Recovery Scale

ABSTRACT

Background: The implementation of effective safety management systems and the promotion of a safety culture in industries have significantly reduced the number of incidents and injuries among workers. Notwithstanding this, some reported incidents and injuries have been attributed to the impact of occupational fatigue combined with insufficient time for workers to recuperate. The prevalence of occupational fatigue and its associated risk factors varies across industries, particularly in the mining industry, which is characterized by multiple risk factors exposure. Identifying the prevalence of fatigue and its associated risk factors is thus a critical issue for occupational health and safety of mine workers and industrial property, especially in Tarkwa, which has a relatively higher concentration of mining industries, including AngloGold Ashanti Iduapriem mine

Objective: The purpose of this study was to identify risk factors of occupational fatigue among mine workers at AngloGold Ashanti Iduapriem Mine in Tarkwa.

Methods: A cross-sectional study involving 252 participants in AngloGold Ashanti Iduapriem mine Limites (AAIL) was conducted using a questionnaire to collect data on socio-demographics, work environmental stress, general health, and lifestyle factors. The Chalder Fatigue Scale (CFQ) was used to determine the prevalence of occupational fatigue. Descriptive analysis was used to demonstrate the characteristics of the study population. Chi-squared test was used to test for significant associations between socio-demographic, work environmental stress, health-related and lifestyle-related variables, and the summary occupational fatigue variables using bivariate analysis. The level of statistical significance was set at 95% ($p < 0.05$). To determine the factors that influence occupational fatigue, a multivariate logistics regression model was created.

Results: The study included 252 workers, of whom 223 (88.49%) were males and 29 (11.51%) were females, with a mean age of 41 years (SD ± 8.9). Among the respondents, 9.1% had experienced occupational fatigue in the past week. Exposure to poor lighting (OR = 3.78), poor air circulation (OR = 3.23), not engaged in any form of exercise (OR = 3.06), sleep deprivation (OR = 4.01) and experience of psychological symptoms (OR = 3.11) were found to be related to occupational fatigue.

Conclusion: Risk factors of occupational fatigue among workers at AAIL were exposure to poor lighting, poor air circulation, not engaging in any form of exercise, sleep deprivation and experience of psychological symptoms, particularly depression.

Key words: Risk factors; occupational fatigue; mine workers

CHAPTER 1

INTRODUCTION

1.1 Background

Occupational fatigue has received much attention in recent years in industries because of its association with worker safety and health (Yazdi & Sadeghniiat-Haghighi, 2015). According to some research, occupational fatigue could be defined as an occupational health hazard that is normally expressed as a feeling of exhaustion or reduced psychological and physical function from non-restorative sleep and work environment stress factors such as noise, temperature, and vibration (CDC, 2021, Pelders & Nelson, 2019a & Lock, 2018). The reduced psychological and physical function of a worker due to occupational fatigue can lead to human errors that can cause accidents that cause significant material damage and human injury in the workplace (Butlewski et al., 2015). Occupational fatigue can be acute or chronic. Usually, acute fatigue resolves after a brief period of rest or when the task is changed, while chronic fatigue is considered to be brought on by continuing to exert oneself while under the influence of unhealthy causes (Son et al., 2019). Occupational fatigue is therefore a critical issue for workers' health and the safety of workers and property.

Recent cross-sectional studies in Japan, Switzerland, Ukraine, and the United States of America have reported prevalence range of fatigue among the general adult population to be from 3.7 % to 21.9 % (Aritake et al., 2015; Friedberg et al., 2015; Galland-Decker et al., 2019). This range varies from occupational fatigue prevalence, 17.1% to 57.9 % obtained from similar studies conducted among health, security and manufacturing industry workers in Norway, Taiwan, Turkey, and the United States of America (USA)

(Buchvold et al., 2019; Fekedulegn et al., 2017; Lu et al., 2017; Tang et al., 2016; Terzi, 2015). A higher prevalence of occupational fatigue ranging from 14.7 % to 65 % have been reported in the mining industry from studies among shift workers for a Ghana-based surface gold mining company, an Iranian copper extraction industry, and a South African platinum mine (Asare et al., 2013; Khoshakhlagh et al., 2017; Martell, 2018; Pelders & Nelson, 2019a). The comparatively higher burden of occupational fatigue observed in the mining industry could possibly be related to a multidimensional combination of occupational fatigue exposures in the mining environment (Bauerle et al., 2018).

According to some studies (Bazazan et al., 2014; Stuetzle et al., 2018) socio-demographic factors such as age, sex, marital status, educational level, and a specific occupation in an operational set-up, may influence fatigue. Age and marital status were found to be linked with fatigue in a study of female medical personnel in China. (Cai et al., 2018). A similar study in Northern Sweeden in the general population identified age and sex as determinants of fatigue (Engberg et al., 2017). A study of a large population of Dutch workers discovered a link between occupational fatigue and a higher educational level (Verdonk et al., 2010). Certain occupations, such as mining, have been linked to occupational fatigue, particularly when physically strenuous activities are performed in an unsuitable work environment. A study conducted in Iran to investigate the relationship between work-related physical trauma and occupational fatigue in the copper extraction industry discovered a significant link (Khoshakhlagh et al., 2017).

A study that looked at the links between occupational fatigue and work environment stressors in a group of workers discovered that occupational fatigue can be caused by an accumulated amount of stress, including work environmental stress (Rose et al., 2017). Studies on the function of the physical work environment in occupational fatigue, according to Sander et al., (2019), demonstrate that the work environment has a major impact on employee fatigue. Some studies show that work environment stress factors such as long working hours, longer shift duration, and physical work environment stress factors including excessive heat, noise, and vibration can contribute to fatigue that could even lead to poor health (Heidari et al., 2021; Krishnamurthy et al., 2017; Park et al., 2020; Sagherian et al., 2017). Kim et al., (2019) found a link between long commuting durations to work and sleep in a Korean cross-sectional study of persons who work three days or more per week, validating the impact of sleep on fatigue.

A comprehensive evaluation of peer-reviewed articles on the consequences that occupational fatigue and sleep deficiency have on an individual's general health by Phegley, (2017), found a close association between sleep deficiency and fatigue. The report attributes many industrial accidents to the effect of occupational fatigue among workers. Meanwhile, an Australian cross-sectional study of an adult working population has revealed a similar relationship between insufficient sleep and occupational fatigue (Skinner & Dorrian, 2015). Occupational Fatigue has also been linked to psychological symptoms such as depression, according to a study conducted to determine the prevalence of fatigue and factors associated with fatigue among female medical workers (Cai et al., 2018). The Four-Dimensional Symptom Questionnaire (4DSQ) (Chalder et al., 1993) is a self-report questionnaire that is commonly used to access a person's psychological symptoms. According to a systematic review on prospective studies about job burnout, it is evident that psychological issues particularly, depression exists among some members of the adult working population (Salvagioni et al., 2017). The findings of a South African workplace depression study including 1,061 employed persons revealed that depression was substantially linked to presenteeism evidenced by poor working behaviors and job performance (Petrus & Korb, 2015).

Additionally, similar research in the mining industry has also shown that certain lifestyle exposures such as alcohol intake, recreational drug use, and smoking have the ability to influence occupational fatigue among workers (Frone, 2016; Theron, 2014). For example, in a cross-sectional study to explore the association between sleep and wake-promoting drug use and the health of police officers, smoking and high intake of substances like caffeine were found to be associated with fatigue-related errors (Ogeil et al., 2018). Yet, a Chinese cross-sectional study of female medical workers found a link between fatigue and lifestyle factors like exercise and diet (Cai et al., 2018).

Unlike in other countries where there is sufficient information about occupational fatigue among workers, research about factors that influence occupational fatigue among workers, especially those in the mining industry, has been overlooked. Considering the high concentration of mines in the Tarkwa Nsuaem Municipality (Akabzaa & Darimani, 2001) and the fact that gold mining has a higher-than-average incidence of occupational health problems (Bauerle et al., 2018) including fatigue, one would perceive that the prevalence of occupational fatigue is high among workers in the gold mining industry in Tarkwa. Therefore, this study seeks to determine the prevalence and the factors that influence occupational fatigue among workers at the AngloGold Ashanti Iduapriem Mine, Tarkwa.

1.2 Problem statement

Research reveals that efficient safety management systems and safety culture promotion in industries have considerably helped reduce incidence and injuries among workers (Bahn, 2013). However, the occupational health concern of workers about the negative consequences of fatigue, combined with insufficient opportunity for workers to recuperate, still remains a challenge (Toker & Melamed, 2017). The detrimental effect of mental fatigue, especially from sleep deprivation, that adversely affects decision-making and physical performance still remains a challenge (Powell & Copping, 2010). Intense physical occupational fatigue, which has also been associated with high worker turnover in organizations (Kołodziej & Ligarski, 2017), is also a major concern for employee wellness. Additionally, the practice of operating mobile mining equipment over long hours, especially during night shifts, can precipitate the effect of mental and physical fatigue and bring about accidents (Pelders & Nelson, 2019a). According to Stemn, (2019), 85% of all injuries and 90% of all deaths in the Ghanaian mining industry are attributable to the impact of the work environment, mainly from hand tools, mining mobile equipment, and its parts. These high rates could be attributed to the worker's physical fatigue. The environmental hazard, particularly flying dust to the eyes, reported by 39.7% of the workers in a Tarkwa-based gold mining company in a cross-sectional study (Ocansey et al., 2012), could easily influence fatigue in the workers. The association of environmental factors with occupational fatigue and its impact on the quality of life has also been demonstrated by Schakel et al., (2019) in a study to access the relationship between fatigue and visual impairment severity. According to unpublished data from the safety department at the AngloGold Ashanti Iduapriem Mine in Tarkwa, from 2017 to 2020, 3% to 16% of incidents, most of which occurred during the long night shift work, were attributed to the impact of occupational fatigue, most likely resulting from prolonged sleep deprivation. The fact that workers in the mining industry are prone to a variety of exposures resulting in physical and mental fatigue, the incidence and factors that influence fatigue among mine workers could be high. Exposure to multiple factors that influence occupational fatigue among mine workers can affect the health and wellbeing of the workers. Hence, it is important to understand the risk factors that influence occupational fatigue among workers at AngloGold Ashanti Iduapriem Mine Limited, Tarkwa

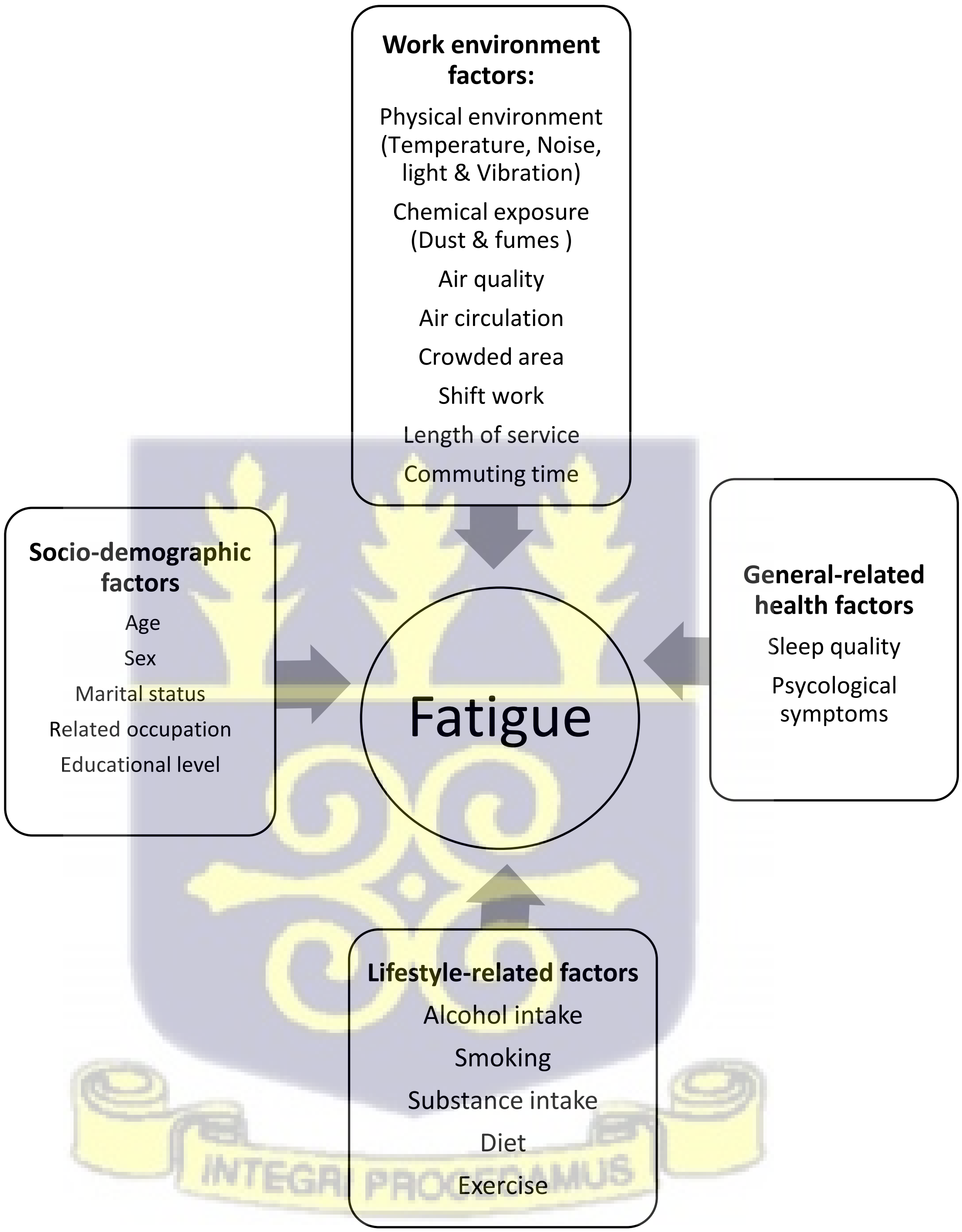
1.3 Problem justification

With rising worldwide demand for important minerals such as gold, decreasing ore quality, and high-risk factors such as occupational fatigue connected with mining, the issue of occupational health and safety management in the mining sector is becoming more prevalent (Amponsah-Tawiah & Mensah, 2016; Maus et al., 2020). Yet, industrial and occupational health-related indispositions are on the rise among workers in developing countries like Ghana (Amponsah-Tawiah & Mensah, 2016; Khan, 2013). As a result, the mining industries of these mineral-rich developing countries are particularly vulnerable to occupational fatigue. Occupational health programs are mainly concerned with preventing illness as a result of working conditions, while safety programs are concerned with preventing injuries and mitigating the loss and harm to lives and property as a result of those accidents (Amponsah-Tawiah & Mensah, 2016). When risk factors for occupational fatigue are not identified and controlled, their negative effects include more than just lost productivity and accidents.

The incidence of occupational fatigue and the factors that influence it have received insufficient practical consideration in most industries' occupational health management.

According to the literature, the effect of occupational fatigue can be the cause of certain occupational health and safety issues, such as psychological and physical imbalances in the worker. From research in some parts of the world, workers are easily exposed to the effects of occupational fatigue because the unique factors that affect it in the respective companies have not been recognized and addressed. Accordingly, the number of workers exposed to fatigue can be minimized if the risk factors for occupational fatigue among the workers on the mine are identified and controlled. As a result, the aim of this study is to determine the baseline prevalence of occupational fatigue and associated risk factors among mine workers at the AngloGold Ashanti Iduapriem Mine in Tarkwa Municipality. The findings from this study may help modify educational content on occupational fatigue and control measures for occupational fatigue management among workers on the mine.

Figure 1.1: Conceptual framework for factors that influence occupational fatigue



1.4 Conceptual Framework Narration of risk factors of occupational fatigue

The scope of this study, as shown in Figure 1, is a conceptual framework that provides a graphical perspective of the risk factors of occupational fatigue among miners. The factors are categorized as socio-demographic, work environmental, general-related health, and life style.

Socio-demographic factors have been found to influence occupational fatigue among workers (Marinaccio et al., 2013; Theofilou et al., 2021). In a longitudinal study involving people from various occupational backgrounds, it was discovered that aging has a positive effect on occupational fatigue (Åkerstedt et al., 2018). The marital status of workers can influence their fatigue management. The married have been found to manage occupational fatigue better than the unmarried because they are likely to have their partner provide them with emotional support. The level of education of a person can have an effect on their occupational fatigue level. While some studies found that the highly educated experienced more occupational fatigue than the less educated (Verdonk et al., 2010), others, on the contrary, found that the highly educated had lower occupational fatigue levels (Engberg et al., 2017). There is a widespread belief that those with occupation in the mining industry experience more occupational fatigue, which is attributed to the nature of their work.

Work environment stress factors, including exposure to noise, extreme temperatures, vibration, poor lighting, toxic chemicals, dust, poor air quality, and poor air circulation, have been found to have a link with occupational fatigue (Agarwal, 2018 & Chao et al., 2013). Work shifts, particularly rotating night shifts, contribute to occupational fatigue (Ferri et al., 2016). The length of service of workers, particularly in the mining sector, has been linked to occupational fatigue (Pelders & Nelson, 2019).

Occupational Fatigue has been linked to general health-related factors such as sleep disruption, which results in sleep deprivation. Sleep deprivation and psychological problems are closely linked (Altun et al., 2012).

Lifestyle factors such as alcohol and substance intake, and smoking have the tendency to make the worker tired and cause fatigue (Son et al., 2016; Thørrisen et al., 2019; Valentino & Volkow, 2020). A poor food plan may result in a decrease in the amount of energy necessary for work, resulting in fatigue. In a study in South Africa, a lack of exercise has been linked to fatigue (Pelders & Nelson, 2019a).

1.5 General objectives

To assess factors influencing occupational fatigue among mine workers at AngloGold Ashanti Iduapriem Mine in Tarkwa.

1.6 Specific objectives

The specific objectives of the study were to:

1. Determine the prevalence of occupational fatigue among workers at AngloGold Ashanti Iduapriem Mine, Tarkwa.
2. Identify socio-demographic factors associated with occupational fatigue among workers at AngloGold Ashanti Iduapriem Mine, Tarkwa.
3. Identify work environment stress factors that contribute to occupational fatigue among workers at AngloGold Ashanti Iduapriem Mine, Tarkwa
4. Determine general health-related factors of occupational fatigue among workers at AngloGold Ashanti Iduapriem Mine, Tarkwa

5. Determine lifestyle factors that contribute to fatigue among workers at AngloGold Ashanti Iduapriem Mine, Tarkwa.

1.7 Research question

This research questions for the study were:

1. How prevalent is occupational fatigue among workers at AngloGold Ashanti Iduapriem Mine?
2. Which socio-demographic factors influence fatigue among workers of AngloGold Ashanti Iduapriem Mine?
3. Which work environmental factors contribute to fatigue among workers at the AngloGold Ashanti Iduapriem Mine?
4. Does general health-related status play a role in the fatigue among workers of AngloGold Ashanti Iduapriem Mine?
5. Does lifestyle-related factors contribute to fatigue among workers at AngloGold Ashanti Iduapriem Mine?

CHAPTER TWO

LITERATURE REVIEW

2.1 Occupational fatigue

In occupational health and safety practice, occupational fatigue is often thought of as the state of being extremely tired or sleepy as a result of a variety of factors, such as sleep deprivation, continuous mental or physical work, or prolonged stress or depression that impairs one's ability to perform a job safely and effectively (Azmoon et al., 2018). Acute and chronic occupational fatigue are two different types of fatigue. Acute occupational fatigue typically, resolves after a short period of rest or when the work is changed. Chronic occupational fatigue, on the other hand, is thought to be linked to poor health conditions and is induced by continuing to exert oneself while fatigued (Son et al., 2019). Fatigue might also refer to mental, physical, or subjective conditions.

Mental fatigue can lead to inaccurate decisions and decreased alertness, which can jeopardize workplace safety as well as employee wellness (Caldwell et al., 2019c). Reduced alertness among workers frequently leads to errors, accidents, and injuries, especially when operating fixed or mobile devices, performing critical tasks that require a high level of concentration, working at a height, or working night shifts (Bendak & Rashid, 2020; Chang et al., 2019). According to some research, fatigue induced by interference from the brain (prefrontal cortex) has a direct impact on sensorimotor system properties. The sensorimotor system is disrupted as a result, making voluntary control of movement precision difficult, especially during tasks that require both physical and mental processing (Hamacher et al., 2016; Mehta & Parasuraman, 2014). The central nervous system (CNS) is the source of central fatigue, which reduces neural drive to the muscles. Muscles require innervation from the neuromuscular junction to function. Changes at or distal to the neuromuscular junction cause peripheral fatigue, normally explained as physical exhaustion (Cavuoto & Megahed, 2016).

The physical manifestation of occupational fatigue is characterized by physical exhaustion or physiological weakness, usually limited to the muscles. Muscle fatigue occurs when a person performs a physical task for an extended period of time, usually accompanied by a decrease in the person's ability to generate force as a result of the muscle's failure to sustain the needed level of strength throughout the activity (Abd-Elfattah et al., 2015; J. J. Wan et al., 2017). In a Danish study about the relationships between work exposures and bodily fatigue, it was discovered that while various single-factor exposures were linked to increased physical fatigue, the most significant relationships existed in the combination of the different exposures (Bláfoss et al., 2019). Prolonged exposure to a combination of different fatigue factors may alter certain physiological responses, including metabolic disorders, cardiovascular and mental health conditions.

Physiological responses, including tiredness, drowsiness, sleepiness, weariness, and lethargy, have been used as subjective indicators for measuring occupational fatigue in research using appropriate scales. Subjective responses to fatigue are sometimes manifest in the short term. Employees who experience short-term occupational fatigue may feel sleepy at work, have a decreased capacity to engage in interpersonal contact, be unable to focus, make poor decisions, have sluggish reflexes, and/or arrive late to work. Other subjective responses to fatigue include drowsiness, headaches, concentration problems, dizziness, and the need for extra sleep on off-duty days (Lasota & Hankiewicz, 2020).

Conditions such as metabolic, cardiovascular and mental disorders such as depression, have been associated with long-term exposure to fatigue risk factors (Akturk & Kavak, 2019). Short-term fatigue is easily alleviated by rest or lifestyle changes, while long-term fatigue is characterized with tiredness that persists for more than 6 months and is not relieved by rest (Townsend et al., 2020; J. Wan et al., 2017). The circadian function is also important for occupational fatigue, particularly for shift workers. Each of these types of fatigue does not occur in isolation, but rather interacts with one another to alter worker ability and risk of injury. Sometimes, when a worker's desire to achieve relevance in an organization is delayed or hindered, occupational fatigue may set in and provoke an emotional response of apprehension. The absence of such a desire enhances the possibility of apathy as well as depression. Although managing emotions is a time-consuming and cognitively draining process, research shows that the ability to control emotions is critical for good physical and mental health (Grillon et al., 2015).

2.2 Relationship between stress, occupational fatigue and job burnout

The relationship between stress, occupational fatigue, and job burnout has been discussed in the literature on many occasions. The obvious connection between them appears to be the progression from one state to the next over time, with all of the complexities that entails. While stress is a reaction to change that causes physical, mental, or psychological strain as a result of any demand imposed on it that exceeds the limit of available resources, occupational fatigue is a response to previously perceived stress that can affect performance and function. When recovery from stress, which can happen after work and during sleep, is hampered, and prolonged circumstances, such as long work days, are experienced, job burnout occurs (Ismail et al., 2015; Kocalevent et al., 2011; Maslach et al., 2001; Toker & Melamed, 2017).

2.3 Relationship between socio-demographic factors and occupational fatigue

The association between socio-demographic factors and occupational fatigue has been revealed in literature (Masson et al., 2015). Usually, as one ages, occupational fatigue sets in as a result of an increase in susceptibility to ailments and endurance deterioration, especially in labour-intensive jobs like mining. An Iranian cross-sectional study to assess worker fatigue in an iron ore mining company discovered a relationship between occupational fatigue and age (Halvani et al., 2009). Regardless of geography, the mining sector has traditionally been a male-dominated business. Several attempts have been made throughout the years to boost the female population in the mining industry, but with little success. Female mine workers are more fatigued as a result of the interplay between the home, market and work environments. Long shifts and long hours add to the occupational fatigue level in the work–life of mine workers, particularly female partners, resulting in a drop in full-time labour force participation (Peetz et al., 2014). The Olatunji & Mokuolu, (2014) study demonstrated the effect of marital status on work fatigue. They discovered that married people suffer less stress and possibly, less occupational fatigue than their single counterparts. The explanation for the married experiencing less stress was ascribed to the fact that a married worker receives emotional support from his or her spouse to alleviate job anxiety after a long day's work. People's educational background can influence their health seeking behaviour. The educated are more likely to be aware of and proactive about their health in terms of adopting a lifestyle that will lower their risks of becoming fatigued at work. On the contrary, a study of a section of Dutch employees discovered a link between occupational fatigue and a higher educational level, particularly among women (Verdonk et al., 2010). According to (Bauerle et al., 2018), some studies have argued that mining related occupation, in particular, is more prone to occupational fatigue than other industries, and this is attributed to a combination of factors unique to mining environments that are associated with occupational fatigue.

2.4. Work environment stress factors and their relationship with occupational fatigue

Work environment stress factors including the physical and chemical environment, shift work, length of service and commuting time have been reported to be important contributors to both acute and chronic occupational fatigue in workers. According to Agarwal (2018) and Chao et al. (2013), work environment stress factors such as noise, temperature extremes, poor lighting, body vibrations, hazardous substances, dust, poor air quality, and limited air circulation contribute to occupational fatigue among workers. In a study conducted in a French chemical plant to investigate potential links between noise and fatigue, noise exposure had the greatest influence on occupational fatigue. The study revealed that old-aged shift employees were more fatigued when they were exposed to the highest levels of noise (Saremi et al., 2008). According to a previous study, chemical compounds such as high carbon monoxide concentrations from mobile or stationary machinery might create poor air quality in vehicle cabins due to low oxygen levels. Drowsiness and fatigue may occur as a result of the low air quality (Galatsis, 2000).

Shift work has been related to a variety of health effects, according to a study done in Iran's mining industry. In the study, a comparison of findings between shift workers and day workers revealed that shift work had an effect on the amount of sleep, alertness, life satisfaction, and job performance. Personal lives and family satisfaction of shift workers were also impacted. (Omidi et al., 2017). Workers may use a variety of commuting methods to get to work. Yet, some studies have linked long commuting time to work to occupational fatigue symptoms (Chatterjee et al., 2020; Künn-Nelen, 2015). Employees who have a long commute are more prone to becoming unwell as a result of high stress and fatigue. Long commutes limit sleeping time and, as well, result in poorer health outcomes than short commuters. Long commuters could incur significant financial and non-monetary commuting costs (Wang et al., 2021) including, occupational fatigue.

2.5 General health-related factors and their relationship with occupational fatigue

The physiologic desire for sleep and the circadian sleep cycle of drowsiness are two important biological factors that affect occupational fatigue as far as the general health of a worker is concerned. In terms of occupational fatigue management, the quality of one's sleep is critical. The biggest cause of occupational fatigue among workers is thought to be a lack of sleep. Insufficient sleep is said to be the primary cause of occupational fatigue among workers (Caldwell et al., 2019c). According to the American Academy of Sleep Medicine and the Sleep Research Society, adults should sleep 7 or more hours a night on a regular basis to achieve optimal health. Sleeping less than 7 hours each night has been associated with poor health impacts such as weight gain and obesity, diabetes, hypertension, heart disease, stroke, depression, impaired immunological function, and an increased risk of fatal accidents (Watson et al., 2015).

According to some research, certain distressing chronic medical conditions, such as severe diabetes and hypertension, may contribute to fatigue, resulting in a reduction in positive well-being of people, especially workers (Fan & Smith, 2018; Yoo et al., 2014).

Mental health issues can have major effects at work, both for individuals and for organizations. Longer working hours, according to a study by (Afonso et al., 2017), are linked to lower mental health and higher levels of anxiety and depression symptoms. Adults who suffer from mental and behavioral health issues have the highest incidence of mood and substance use disorders. Psychological problems among these vulnerable adults, particularly workers, must be detected and managed in the workplace so that the negative consequences of mental illness can be reduced. These workers can be supported through institutional employee assistance programs, which are among the services offered. (Goetzel et al., 2018).

People suffering from anxiety and depression might experience a variety of psychosomatic symptoms. In psychosomatic disorders, there is a wealth of knowledge about the interplay between physical and mental health. According to these findings, such symptoms must be due to either a physiological malfunction or a psychological cause. According to some estimates, 66 % of employees blamed their illnesses on psychological or combined psychological and physical reasons (Nimmo, 2015). In a large population study, depression was found to have a significant increasing effect on general somatization (Mostafaei et al., 2019).

2.6 Relationship and impact of lifestyle-related factors on occupational fatigue

Lifestyle factors such as alcohol abuse, tobacco and marijuana smoking, and intake of all addictive substances have negative health consequences (Pesta et al., 2013). Workers in high-fatigue jobs, particularly blue-collar workers in the mining industry, are more likely to turn to drugs or alcohol to relieve their fatigue (AAC, 2021). Workplace alcoholism and the influence of addictive substances can be tremendously costly to an organization.

Alcohol and addictive substance intake do not only raise the likelihood of an employee being injured; it can also lead to an increase in on-the-job accidents. In an Australian coal miner's study, a considerable contribution of various individual lifestyle characteristics, including substance usage and previous day's alcohol intake, were found to be associated with occupational fatigue (Tynan et al., 2017). Alcoholism has the potential to harm one's mental health. Previous research has linked higher self-reporting of alcohol and cigarette addiction and fatigue to challenges in distinguish and expressing thoughts (Obeid et al., 2020).

Cigarette smoking can produce changes in skeletal muscle that lead to muscular dysfunction and fatigue (Degens et al., 2015). According to the literature, some workers use psychoactive substances such as nicotine (in cigarettes) and marijuana to help minimize fatigue and enhance their willingness to work. Nonetheless, these substances are known to have negative consequences on individuals and society (Kagabo et al., 2020).

To cope with the stress of shift work, some shift workers take stimulants, sedatives, or both. Low to moderate dosages of stimulants, such as amphetamine and caffeine, have been shown to be effective antidotes to sleep and fatigue-induced mood and performance declines (Keith et al., 2017). Sleep deprivation, in turn, is a risk factors for substance misuse, and the severity of sleep disorders can predict the outcome of substance use disorders, including fatigue at work (Valentino & Volkow, 2020).

Irregular and poor dietary habits have been identified as a risk factor for chronic health conditions, which can also impair the worker's overall well-being and lead to occupational fatigue. The dietary habits of shift workers have been linked to fatigue (Heath et al., 2016).

However, according to (Null & Pennesi, 2017), a workplace intervention involving dietary and physical activity modification could have significant benefits for people suffering from moderate to severe depression and anxiety. According to (J. Wan et al., 2017), inhaling hypoxic air can dramatically increase muscular fatigue, but increasing oxygen delivery to muscles through regular exercise reduces muscle fatigue and promotes muscle efficiency during prolonged activity involving the muscles. Exercise is relatively cheap but has a great potential to reduce occupational fatigue associated with work. An evaluation of the efficacy of a regular exercise procedure to reduce work fatigue in a randomized control trial demonstrates that exercise is a powerful medicine for people who comply, a good indicator of well-being for workers (de Vries et al., 2017).

2.7 Occupational fatigue management at AngloGold Ashanti Iduapriem Mine

Like any other industrial mining company in Ghana, modalities for the management of fatigue in AngloGold Ashanti Iduapriem Mine Limited (AAIL) are usually aimed at equipping the workers with the capability to identify and effectively deal with the causes of occupational fatigue at the personal level through induction and training. During the initial site induction, all employees and contractors are educated about occupational fatigue management. The scope of education at the induction program includes the need for adequate sleep, recognition of the body clock (circadian rhythm), signs of fatigue, lifestyle factors such as use of caffeine, drugs and alcohol and their effects on the body, how to manage occupational fatigue, diet and the importance of personal fitness and health. Workers who operate heavy stationary or mobile equipment, such as haul truck receive annual refresher training on occupational fatigue management.

Beyond the personal level of occupational fatigue management, each department conducts a risk assessment on work hours and cycles to identify risk/factors that may be associated with fatigue. The length of work shifts is factored into the risk assessment. Night shift, type of work (for example, physical exertion), travel arrangements (particularly when the potential end-of-shift travel time exceeds one hour), and environmental and climate conditions (for example, extreme heat) are all taken into account. Work schedules that are irregular or unpredictable, such as a shift roster with an irregular or unplanned pattern, or more than four 12-hour night shifts in a row, or more than five 8-hour night shifts in a row, are considered to have a higher-than-normal risk of negatively impacting an individual's ability to reduce occupational fatigue. Other higher than normal patterns include work schedules/rosters that do not allow for 7 to 8 hours of uninterrupted sleep in each 24-hour period, less than 36 hours off after a night shift and 12-hour shifts involving critical monitoring tasks, heavy physical workload, and potential exposure to harmful agents/substances and many more.

Managers ensure that work cycles or hours for workers conform to basic guidelines provided by the company. Night shift employees are required to have a break of 48 hours of non-working time after a night shift before resuming work on the day shift. Each day's minimum time away from work must be sufficient to allow workers to get an average of eight (8) hours of sleep and a minimum of six (6) hours of sleep in a row. Employees are scheduled such that they are able to take a 48-hour non-working break after finishing the night shift before starting the day shift.

Supervisors conduct fatigue assessments at random in the workplace, as part of an incident investigation, when a worker appears to be affected, and when regular rostered hours /

cycles are changed. Employees are also urged to undertake fatigue self-assessments both before and during work. A roster risk assessment tool is also provided, which assists supervisors and workers in determining their fatigue risk levels.

According to unpublished data from the AngloGold Ashanti Iduapriem mine's safety department, the majority of the incidents involving vehicles during the night shift, were fatigue-related, presumably as a result of insufficient sleep rest throughout the shift schedule. It is reasonable for one to conclude that monotonous and repetitive occupations with little or no variation in mental stimulation make workers vulnerable to occupational fatigue. As a result, SmartCaps are offered to individuals whose jobs require a high level of attentiveness and repeated actions, such as haul truck operators. A SmartCap is a fatigue monitoring wearable that provides real-time fatigue measurements for vehicle drivers or heavy equipment operators. The device includes a sensor band (LifeBand) lining that can be easily integrated into any headwear, including the equipment operator's helmet. The data is wirelessly delivered to an in-cab display after brainwave information is captured using eletroencephalography (EEG) to calculate a measure of sleepiness. Every second, the SmartCap determines the wearer's level of alertness. A Bluetooth-enabled device, such as a smartphone, displays confirmed alertness or drowsiness information. The display informs the operator that his or her fatigue level is unknown if it is not identified within a two-minute period (Meng Zhang, 2014).

2.8 Some common occupational fatigue assessment tools for studies among workers

There are different subjective measurement tools available for assessing fatigue among different categories of people. Some of the commonly used tools for assessing fatigue among workers include the Chalder Fatigue Scale (CFQ), Fatigue Assessment Scale (FAS), Check List individual Strength (CIS), Swedish Occupational Fatigue Inventory (SOFI) and Occupational Fatigue Exhaustion Recovery Scale (OFER) (Rahimian Aghdam et al., 2019).

The CFQ is a commonly used self-reported scale for assessing the severity and level of physical and mental fatigue in working people and chronic fatigue syndrome patients. It consists of 11 items that are scored on a four-point Likert scale from 0 (better than usual), 1 (no worse than usual), 2 (worse than usual), and 3 (worse than usual) (Morriss et al., 1998; Terluin et al., 2004). In a Korean study, the scale's validity and reliability were tested and found to be satisfactory, as demonstrated by Cronbach's alpha coefficients of 0.963 for physical fatigue and 0.958 for mental fatigue (Ahn et al., 2020).

According to (Rahimian Aghdam et al., 2019), the FAS is a one-dimensional fatigue measure with a 5-point Likert scale ranging from 1 (never) to 5 (always). It is made up of ten items, nine of which have been extracted from 4 fatigue scales: the Checklist Individual Strength (CIS), the Maslach Burnout Inventory's Emotional Exhaustion subscale, the WHO Quality of Life Assessment Instrument's Energy and Fatigue subscale, and the Fatigue Scale. The FAS's reliability and validity were assessed in a workforce based in the United States and found to be an excellent tool for determining the extent of fatigue among workers (Mingzong Zhang et al., 2015).

The CIS scale is a multivariate instrument for assessing chronic fatigue. The CIS is a 20-item self-reported scale with a 7-point Likert scale that measures several features of fatigue. The CIS measures a decline in activity level, a loss in attentiveness and motivation, as well as a subjective sensation of exhaustion. The validity and reliability of using CIS to assess fatigue has been evaluated and found useful in people undergoing musculoskeletal therapy (Ergin & Yildirim, 2012).

The SOFI was developed to measure fatigue after work. This scale includes 20 items assessed on a 7-point Likert scale to evaluate labor fatigue between 0 (not at all) to 6 (to a very high degree). These are divided into 5 types, including bodily discomfort, energy deficiency, motivation deficiency, physical exercise, and sleepiness. The validity and reliability of the 20-point SOFI for assessing the aspects of work-related fatigue has been determined in Korean workers and found to be satisfactory (Lee et al., 2021).

The OFER provides a 15-point scale for fatigue measurement. It is divided into three areas: chronic fatigue, acute fatigue and inter-shift recovery. The result is a Likert scale of 7 points to evaluate the extent of fatigue, ranging from 0. (completely exhausted). The OFER tool consists of a subscale evaluating the way the job shifts are recovering. This type is an essential moderator for improving chronic fatigue characteristics. The OFER scale has been recommended as a very useful tool for studies on work-related fatigue (Winwood et al., 2005).

Among all the fatigue scales discussed, the Chalder Fatigue Scale appears very convenient to use because of the comparatively limited number of questions that make up the content. The option of using it either in a bimodal or ordinal format also makes it very convenient to use. The self-administered version of the Chalder Fatigue Scale (CFS) is freely available for use. It is one of the most commonly used scales for assessing worker fatigue. Its validity and internal dependability have also been established through research. Its application has been shown to be useful in the treatment of psychological and physical exhaustion in the working population, such as among miners. Because of the very small number of questions that make up the content, the Chalder Fatigue Scale appears to be quite simple to use. It is also incredibly easy to use because it provides the option for use in either a bimodal or ordinal scale format. It is completely free to use. Its scope is quite broad, allowing for both psychological and physical aspects of measurements of fatigue to be made.

CHAPTER THREE

METHODS

3.1 Study design

A cross-sectional study was adopted to carry out the study among mining workers at the AngloGold Ashanti Iduapriem mine Limited (AAIL) from December 2021 to January 2022.

3.2 Study area

The study was carried out at the AngloGold Ashanti Iduapriem mine Limited (AAIL) located in the Tarkwa Nsuaem Municipality in the Western Region. Tarkwa-Nsuaem Municipality is located between Latitude 45° 5′ and Longitude 55° 5′ (GSS, 2014). It is about 86km away, northwards from the Western Regional capital, Takoradi. The Tarkwa area is well-known for its substantial mining activities, which is thought to be Ghana's oldest mining site and, as a result, attracts a large number of migrants.

AngloGold Ashanti Iduapriem mine Limited is a subsidiary of AngloGold Ashanti Limited, a global gold mining company. The Iduapriem mine comprises the Iduapriem and Teberebie properties in a 110km2 concession. The mine shares a boundary with the Goldfields Ghana Limited mine in Tarkwa. The Iduapriem mine is an open-pit mine and its processing facilities include a carbon in-leaching (CIL) plant. Iduapriem mine has 658 permanents workers but a total of 2,364 workers, including contractors. Aside from the contract companies, the mine has 9 business departments, namely Geology, Mining, Processing, Finance, Human Resources (HR), Health, Safety and Environment (HSE), Sustainability, Security and Engineering. Of the 9 departments, 6 of them, including Geology, Mining, Processing, HSE, Security and Engineering, operate on a shift schedule.

The company operates two main shift schedules for the workers, morning and night. The morning schedule consists of 10-hour and 12-hour work duration, all of which start at 7:00 am. The second shift schedule is a 12-hour duration from 7:00pm to 7:00 am. The majority of the workers are resident in the Tarkwa township, which is about 24 km to and from the mine site, while some are resident in the company residential quarters closer to the mine site. Workers commute to the mine site in their personal cars, official cars, or hired buses. The various business departments have been strategically positioned across the mine site.

3.3 Source/study population

The source population included all 658 permanent Workers of AngloGold Ashanti Iduapriem mine Limited. From this population, 252 individuals were randomly selected for inclusion into the study after calculating for the sample size, (see section 3.6). A sample factor was derived, (see section 3.5) to help determine how many workers to be included from each department, (see table 3.1)

3.4 Inclusion and exclusion criteria

Permanent employees with a minimum of six months of service were considered eligible for enrollment in the study. Employees with less than six month of employment and those who were not on site during the study period were excluded.

3.5 Sampling

To obtain a fair proportion of workers from each department to be included in the study, the proportionate stratified random sampling technique was adopted. A sampling factor (Sf) of 0.378 was multiplied by the total number of workers in each department to obtain

Thus, Sf = n/N 249/658 = 0.378

3.6 Sample size

The sample size was calculated using the Taro Yamane's formular;

$n = N / (1+Ne^2)$

Where:

n signifies the sample size, N (the population under study) and e (margin of error, 0.05).

$n = 658 / (1+658(0.05)^2)$, Therefore, n = 249

A list of workers in each department was assigned with numbers. All workers assigned even numbers were selected and informed about the study. Those who consented were included.

Table 3.1 Departments population and number of workers needed from each for inclusion

Department	No. of workers available (R)	No. of workers needed = (RM)
Geology	36	14
Mining	40	15
Processing	214	81
Finance	46	17
HR	16	6
HSE	47	18
Security	63	24
Sustainability	18	7
Engineering	178	67
Total	658	249

***Key**: R = number of workers in each department, M = number of workers needed from each department*

3.7 Dependent and independent variables

Occupational fatigue in mine workers was the dependent variable. A state of a feeling of exhaustion or reduced psychological and physical function in the last one week defined as occupational fatigue according to the Chalder fatigue scale.

The independent variables were socio-demographic factors, work environment stress factors, lifestyle-related factors, and general health-related factors. The socio-demographic factors of interest included age, sex, marital status, and educational level. Work environment stress factors included exposure to noise, poor lighting, heat, vibration, poor air quality, poor air circulation, dangerous substances, and crowded work areas. The rest of the environmental stress factors included hours worked per shift, length of service, and commuting time. Lifestyle-related factors included alcohol consumption, smoking of cigarettes or cannabis, engagement in some form of exercise, and habits of eating healthy foods in the last three months. General health-related factors of interest included experience of sleep deprivation, hours of sleep per night, experience of psychological problems in the last two weeks, and the impact of depressive disorder.

Table 3.2 Operational definition of variables

Variable	Operational definition	Scale of measurement	Source of data
Socio-demographic characteristics			
Age	Age at last birthday	Continuous	Questionnaire
Sex	Being male or female	Binary Male Female	Questionnaire
Marital status	Civil status of respondent in relation to marriage	Nominal Single Married	Questionnaire
Educational level	Formal highest education attained	Ordinal Tertiary Secondary Middle/JSS	Questionnaire
Occupation	Occupation categorization in relation to department	Nominal Mining-related Non-mining-related	Questionnaire
Work environment stress factors			
Physical exposure	Perceived increased exposure to noise, heat, vibration, poor lighting and cold temperature during work.	Binary Yes No	Questionnaire
Chemical exposure	Perceived excess exposure to dust, fumes and other dangerous substances during work	Binary Yes No	Questionnaire
Air circulation	Perceived amount of air in circulation	Ordinal Poor Good	Questionnaire
Air quality	Perceived quality of air available to the worker	Ordinal Poor Good	Questionnaire
Shift work	Night work shift	Binary Yes No	Questionnaire
Length of service	Years of service	Continuous	Questionnaire
Commuting time	Time spent from home commuting to work	Continuous Minutes	Questionnaire

General health-related factors

Variable	Operational definition	Scale of measurement	Source of data
Sleep deprivation	Experience of sleep disturbance in the last 7 days	Binary Yes No	Questionnaire
	Average hours of sleep	Continuous	
Psychological symptoms	Experience of psychological symptoms of depression in the last 2 weeks.	Binary Yes No	Questionnaire
Psychological symptoms impact	Depressive disorder impact on functioning	Binary Yes No	Questionnaire
Lifestyle-related factors			
Alcohol intake	Alcohol consumption status of respondent	Binary Yes No	Questionnaire
Smoking	Smoking of cigarette or marijuana status of respondent	Binary Yes No	Questionnaire
Substance intake	Substance intake of psychoactive substance status	Binary Yes No	Questionnaire
Diet	Regular healthy diet intake status of respondent	Binary Yes No	Questionnaire
Exercise	Engagement in aerobic activity for 30 minutes a day or any form of exercise status	Binary Yes No	Questionnaire

3.8 Data collection tools and technique

A structured close-ended pretested questionnaire (Appendix A) was used to collect data on participants' socio-demographic, work environment stress factors, health-related, and lifestyle factors from December 2021 to January 2022. Questions addressing the variables for each of the factors for occupational fatigue considered in this study were adopted from standard questionnaires and modified for use. For data collection on work environment stress factors, questions from the National Institute for Occupational Safety and Health (NIOSH^{TM}) generic job stress questionnaire (CDC, 2017) were used. The NIOSH questionnaire assesses the most prevalent causes of occupational stress, including physical and chemical conditions in the workplace. The validity and reliability of the NIOSH generic work stress questionnaire have been evaluated among firefighting personnel in Iran and found to be suitable for use in a working population (Kazronian et al., 2013).

The Patient-Reported Outcomes Measurement Information Systems (PROMIS) sleep disturbance short form questionnaire was used to measure sleep deprivation as a general health-related factor (NIH, 2008 & Yu et al., 2011). The PROMIS questionnaire assess participant's sleep deprivation due to sleep disturbance. The pure domain of sleep disturbance is measured among adults on an 8-item questionnaire. A study conducted in the United States found that sleep disturbance (SD) questionnaire, had preliminary reliability and validity among adults (Bartlett et al., 2015).

The Patient Health Questionnaire (PHQ-9) was used to screen for psychological symptoms, depression (Spitzer, et al., 2021). Each of the nine items in the questionnaire represents the major depressive disorder elements, according to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition. In the PHQ-9, respondents are required to indicate whether they have been bothered by any of the listed 9-problems during the last two weeks. The Persian version of PHQ-9 has been shown to have good psychometric properties for persons with depression (Ahmadi et al., 2019).

The short form of the alcohol use disorders identification test consumption (AUDIT C) (Babor et al., 2001) questionnaire was used for alcohol consumption assessment as part of the general lifestyle factors. The AUDIT C short form tests for alcohol usage and risk levels. The reliability and validity of the widely used World Health Organization's (WHO) self-administered 3-item AUDIT C have been shown to be high in a study among a section of the Japanese general population (Osaki et al., 2014).

Questions from the alcohol, smoking, and substance involvement screening test (WHO–ASSIST) (Humeniuk et al., 2010) scale were adopted for smoking and substance intake screening. The questions on smoking and substance abuse were adopted for use.

The Chalder Fatigue Scale (CFQ 11) (Chalder et al., 1993) was adopted and used for respondents' fatigue status determination. The CFQ measures the participants' fatigue levels over the previous week. Physical fatigue (7 items) and mental fatigue (4 items) are the two aspects of the measure. This scale's validity and reliability have been examined in China's occupational and general populations and determined to be satisfactory (Jing et al., 2016); and for that matter, it is extensively utilized. According to (Jackson, 2015), reliability coefficients (Cronbach's alpha values) in chronic fatigue syndrome, occupational, and general population research have been high, ranging from 0.90 for the

Likert scoring method to 0.83 for the binary scoring approach. A global binary score of 4 or more equates to fatigue.

3.10 Data quality control

The data collection tool was pre-tested before commencement of study to ensure that quality data is collected for analysis. Investigative assistants were trained and their ability to record participants' responses accurately evaluated. The principal investigator participated actively in the data collection and monitoring of the assistants. Some completed questionnaires were randomly selected and reassessed for errors or omissions and the accuracy of information collected by the principal investigator.

3.11 Data processing and analysis

The data collected were entered into a Microsoft Excel spreadsheet on a Windows 10 computer. For analysis, the data were ordered, coded, and imported into STATA software version 16. Percentages were used to express categorical variables. The socio-demographic characteristics of study participants was presented using descriptive statistics. The results were presented using tables. The chi-squared test and the Fisher's exact test were used to determine significant associations between socio-demographic, work environmental stress, health-related and lifestyle variables, and the summary fatigue variables in bivariate analysis. The level of statistical significance was set at 95% (p0.05). To determine the factors that influence occupational fatigue, a multivariate logistic regression model was constructed.

3.12 Ethical consideration and approval

The study received ethical clearance from the Ghana Health Service Ethics Review Committee (Appendix C).

3.13 Study area approval

The Managing Director, the Senior Manager for Human Resources, the Senior Manager of Health, Safety and Environment, and the Manger for Health of AngloGold Ashanti Iduapriem mine were notified in advance and approval obtained before commencement of the study.

3.14 Informed consent

Participation in the study was voluntary. The participants could withdraw from the study at any time they wished. Informed consent was obtained from participants. In a clear language understood by participants, the content of the consent form was explained. Anyone who agreed to participate signed on the consent form (Appendix B).

3.15 Risk or benefit compensation

Minimal risk was anticipated since some questions could be uncomfortable. Participants were at liberty not to answer questions that might appear uncomfortable to them.

3.16 Confidentiality

The privacy rights of participants were preserved. All personal identifiable information, such as staff identity numbers, was not collected. Data obtained from participants were only used for the purpose of this study. All raw data, including hard copies, are stored securely in a locked file cabinet, and soft copies are similarly secured with a password for a minimum of ten years after the study has been completed.

CHAPTER FOUR

RESULTS

4.1 Socio-demographic characteristics of study participants

The study included 252 workers who completed the questionnaire. The mean age of the workers was 41 years (SD ±8.9), within a range of 23 to 60 years. A good proportion of the workers, 120 (47.6%), were between the ages of 30 and 45, while 38 (15.1%) were 30 years old or younger. Males made up a larger proportion of the workers, 223(88.5%). In terms of marital status, 201 workers (79.8%) were married, 3 (1.2%) were divorced, while 41 (16.3%) workers had never married. According to Table 4.1, the department of occupation of the majority of workers (35.3%) was processing, followed by approximately 29% in engineering, and the least, 1.6%, in geology.

Table 4.1 Socio-demographic characteristics of the study participants (n = 252)

Variables	Frequency	Percentage (%)
Age (yrs)		
≤30	38	15.08
30-45	120	47.62
≥45	94	37.30
Sex		
Male	223	88.49
Female	29	11.51
Marital Status		
Never married	41	16.27
Married	201	79.76
Living together	5	1.98
Divorce	3	1.19
Widowed	2	0.79
Highest Education		
Middle/JSS	16	6.35
Secondary	44	17.46
Tertiary	192	76.19
Department of occupation		
Geology	4	1.59
Mining	18	7.14
Processing	89	35.32
Finance	16	6.35
Human Resources	8	3.17
Health, Safety, and Environment	23	9.13
Sustainability	7	2.78
Security	14	5.56
Engineering	73	28.97

4.2 Prevalence of occupational fatigue

According to the Chalder Fatigue scale, 23 of the 252 respondents studied were fatigued with fatigue score ≥ 4, representing a 9.1 % prevalence.

The main socio-demographic factors for occupational fatigue among the workers considered in this study were age, sex, department of occupation, marital status and highest educational level attained. Table 4.2 illustrates bivariate analysis of the studied socio-demographic factors for occupational fatigue among respondents. Apart from department of occupation, that contributed significantly ($p < 0.05$), to occupational fatigue among the workers in the study, all the other factors, age, sex, marital status and highest education did not contribute significantly to the worker's fatigue status. As shown in Table 4.2, 65.2% of the workers who were fatigued were in the mining-related departments (geology, mining, processing, and engineering) and 34.8% were in the non-mining-related departments (finance, HR, HSE, environment, security, and sustainability).

Table 4.2 Bivariate analysis of the association between socio-demographic factors and the prevalence of occupational fatigue among the study participants

Socio-demographic factors	Occupational fatigue	
	Yes n (%)	**No n (%)**
Total	23 (9.13)	229 (90.87)
Age (yrs)		
≤30	5 (21.74)	33 (14.41)
30-45	11 (47.83)	109 (47.60)
≥45	7 (30.43)	87 (37.99)
	χ^2 (df = 2) = 1.06; P = 0.59	
Sex		
Male	19 (82.61)	204 (89.08)
Female	4 (17.39)	25 (10.92)
	χ^2 (df = 1) = 0.86; P = 0.35	
***Department of occupation**		
Mining related department	15 (65.22)	169 (73.80
Non-mining-related department	8 (34.78)	60 (26.20)
	χ^2 (df = 1) = 7.78; P = 0.008	
Marital Status		
Single	5 (21.74)	41 (17.90)
Married	18 (78.26)	188 (82.10)
	χ^2 (df = 1) = 0.21; P = 0.65	
Highest Education x^1		
Middle/JHS	0 (0.0)	16 (6.99)
Secondary	7 (30.43)	37 (16.16)
Tertiary	16 (69.57)	176 (76.86)
	P = 0.14	

**Mining-related department includes Departments of Geology, mining, processing, and engineering and non-mining depart includes finance, human resources, health, safety and environment, security and sustainability*

x^1: Used Fisher's exact test

4.3 Work environment stress factors for occupational fatigue

Excessive noise, poor light, cold temperature, heat, vibration, poor quality of air, poor air circulation, exposure to dangerous substances, crowded work areas, hours worked per shift, length of service and commuting time were all investigated as work environment stress factors for occupational fatigue. Table 4.3 shows the p-value of exposed and non-exposed respondents to the various work environment stress factors. A bivariate analysis was conducted between the work environment stress factors and the prevalence of occupational fatigue. With the exception of exposures to poor lighting ($p = 0.03$), poor air circulation ($p = 0.03$), and dangerous substances ($p = 0.04$), that were significantly associated with the prevalence of occupational fatigue among the respondents, the rest of the work environmental stress exposures were not significantly associated with occupational fatigue in the workers, as shown in Table 4.3.

Table 4.3 Bivariate analysis of the association between work environment factors and the prevalence of occupational fatigue among the study participants – (n = 252)

Work-related risk factors	Occupational fatigue	
	Yes n (%)	**No n (%)**
Total	23 (9.13)	229 (90.87)
Exposure to excessive noise x^1		
Yes	20 (86.96)	186 (81.22)
No	3 (13.04)	43 (18.78)
	P = 0.78	
Exposure to light		
Yes	15 (65.22)	95 (41.48)
No	8 (34.78)	134 (58.52)
	χ^2 (df = 1) = 4.79; P = 0.03	
Exposure to cold Temperature		
Yes	15 (65.22)	141 (61.57)
No	8 (34.78)	88 (38.43)
	χ^2 (df = 1) = 0.12; P = 0.73	
Exposure to heat x^1		
Yes	19 (82.61)	177 (77.29)
No	4 (17.39)	52 (22.71)
	P = 0.80	
Exposure to vibration		
Yes	15 (65.22)	134 (58.52)
No	8 (34.78)	95 (41.48)
	χ^2 (df = 1) = 0.039; P = 0.53	
Quality of Air		
Poor	16 (69.57)	134 (58.52)
Good	7 (30.43)	95 (41.48)
	χ^2 (df = 1) = 1.06; P = 0.30	
Air circulation		
Poor	15 (65.22)	96 (41.92)
Good	8 (34.78)	133 (58.08)
	χ^2 (df = 1) = 4.60; P = 0.03	
Exposure to dangerous substances		
Yes	18 (78.26)	144 (62.88)
No	5 (21.74)	85 (37.12)
	χ^2 (df = 1) = 8.15; P = 0.04	
Crowded work area		
Yes	10 (43.48)	72 (31.44)
No	13 (56.52)	157 (68.56)
	χ^2 (df = 1) = 1.38; P = 0.24	
Hours worked per shift (hrs/shift) x^1		
≤ 8	19 (82.61)	208 (90.83)
>8	4 (17.39)	21 (9.17)
	P = 0.26	
Length of service (yrs) x^1		
≤5	10 (43.48)	58 (25.33)
5-20	12 (52.17)	150 (65.50)
≥20	1 (4.35)	21 (9.17)
	P = 0.17	
Commuting time (mins) x^1		
≤25	8 (34.78)	58 (25.33)
25-45	10 (43.48)	108 (47.16)
≥45	5 (21.74)	63 (27.51)
	P = 0.60	

x^1: Used Fisher's exact test

4.4 General Health-related factors for occupational fatigue

The general health-related factors investigated include sleep deprivation, hours of actual sleep per night, psychological problems and the impact of depressive disorder on functioning (Table 4.4). Experience of sleep deprivation and psychological problems in the last 2 weeks were significantly ($p = 0.0006$ and $p < 0.0001$ respectively) associated with the prevalence of occupational fatigue among the respondents. Hours of actual sleep attained in the last 7 days and depression disorder impact on respondents' functioning were not significantly associated with the prevalence of occupational fatigue (Table 4.4).

Table 4.4 Bivariate analysis of the association between General Health-related factors and the prevalence of occupational fatigue among the study participants

Risk Factors	Occupational fatigue	
	Yes n (%)	**No n (%)**
Total	23 (9.13)	229 (90.87)
General Health-related Factors		
Experience of sleep deprivation		
…Yes	11 (47.83)	40 (17.47)
…No	12 (52.17)	189 (82.53)
	χ^2 **(df = 1) =11.93; P = 0.0006**	
Hours of actual sleep attained per night in the last 7 days (hrs) x^1		
≤ 5	3 (13.04)	25 (10.92)
> 5	20 (86.96)	204 (89.08)
	P = 0.73	
Experience of any psychological problems in the last 2 weeks		
Yes	16 (69.57)	164 (71.62)
No	7 (30.43)	65 (28.38)
	χ^2 **(df = 1) = 16.25; P<.0001**	
Depressive disorder impact on functioning x^1		
Yes	12 (52.17)	106 (46.29)
No	11 (47.83)	123 (53.71)
	χ^2 (df = 1) = 0.29; P = 0.59	

x^1: Used Fisher's exact test

4.5 Lifestyle-related factors for occupational fatigue

Table 4.5 shows the p-value of lifestyle factors such as alcohol intake, physical activity, and the overall habit of eating healthy foods. Bivariate analysis showed a significant association ($p = 0.02$) of the lack of engagement in physical activity involving aerobics and/or muscle strengthening in the last 3 months with the prevalence of occupational fatigue in respondents as far as their lifestyle factors under study were concerned. The rest of the lifestyle factors were not significantly associated with the prevalence of occupational fatigue in the respondents as shown in table 4.5.

Table 4.5 Bivariate analysis of the association between Lifestyle-related Factors and the prevalence of occupational fatigue among the study participants

Risk Factors	Occupational fatigue	
	Yes n (%)	No n (%)
Total	23 (9.13)	229 (90.87)
Lifestyle Factors		
Alcohol intake x^1		
Yes	1 (4.35)	28 (12.23)
No	22 (95.65)	201 (87.77)
	P = 0.49	
Engage in physical activity involving aerobics and or muscle strengthening in the last 3 months		
Engaged in some form of exercise	14 (60.87)	188 (82.10)
Not engaged in any form of exercise	9 (39.13)	41 (17.90)
	χ^2 (df = 1) = 5.92; P = 0.02	
Overall habits of eating healthy foods in the last 3 months		
Good	7 (30.43)	112 (48.91)
Poor	16 (69.57)	117 (51.09)
	χ^2 (df = 1) = 2.86; P = 0.09	

Note: Nobody smoked cigarette/cannabis. x^1*: Used Fisher's exact test*

4.6 Association of risk factors with occupational fatigue in a multivariate logistics regression model

Multivariate logistics regression was used as the final model to determine the factors that influence occupational fatigue among the respondents. All the factors of occupational fatigue in the initial bivariate analysis were included. The criteria for inclusion of the risk factors in the final multivariate analysis were based on $p < 0.05$. The results demonstrate that exposure to poor light, exposure to dangerous substances, not engaging in any form of exercise, experience of sleep deprivation, and experience of psychological problems were significantly associated with occupational fatigue status among workers at AngloGold Ashanti Iduapriem mine after adjusting for all other factors included in the table 4.6.

In the *work environment stress factors*, participants who worked in environments with poor lighting (OR = 3.78), poor air circulation (OR = 3.23) and those exposed to dangerous substances (OR = 3.78) were more likely to correlate with occupational fatigue. About the *lifestyle-related factors*: Respondents who were not engaged in any form of physical exercise or muscle strengthening involving aerobics in the last three months (OR = 3.06) were more likely to report occupational fatigue than were those who engaged in some form of exercise (reference group). In the *general health-related factors*, participants with higher scores for experience of sleep deprivation (OR = 4.01) and psychological problems in the last two weeks (OR = 3.11) were significantly more likely to report occupational fatigue than their counterparts with lower scores.

Table 4.6 Multivariable analysis of the association between risk factors and prevalence of occupational fatigue among the study respondents

Risk Factors	Crude OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Department						
Non-mining department	1.00	1.00		1.00	1.00	
Mining related department	1.44	0.99-3.25	0.0498	1.18	0.84-4.02	0.0578
Work environmental factors						
Exposure to poor light						
No	1.00	1.00		1.00	1.00	
Yes	2.42	1.06-5.50	0.0291	3.78	1.97-7.23	0.0301
Air circulation						
Good	1.00	1.00		1.00	1.00	
Poor	2.38	1.06-5.41	0.0322	3.23	1.78-7.01	0.0418
Exposure to dangerous substances						
No	1.00	1.00		1.00	1.00	
Yes	2.00	0.77- 5.21	0.1283	3.78	0.69-7.81	0.2310
Lifestyle Factors						
Engage in physical activity involving aerobics and or muscle strengthening in the last 3 months						
Engaged in some form of exercise	1.00	1.00		1.00	1.00	
Not engaged in any form of exercise	2.60	1.19-5.65	0.0243	3.06	1.64-7.65	0.0153
General Health-related Factors						
Experience of sleep deprivation						
No	1.00	1.00		1.00	1.00	
Yes	3.61	1.69- 7.71	0.0017	4.01	2.11-9.12	0.0036
Experience of any psychological problems in the last 2 weeks						
No	1.00	1.00		1.00	1.00	
Yes	4.83	2.07 - 11.27	0.0001	3.11	1.23-12.67	0.0121

CHAPTER FIVE

DISCUSSION

5.1 Main findings

Occupational fatigue was moderate in prevalence among all the participants. Almost one out of ten participants had experienced occupational fatigue in the last week. Exposure to poor lighting, poor air circulation and dangerous substances were the most significant work environmental factors that contributed to occupational fatigue among the study participants. Due to the large work environment of the mine, adequate illumination, especially during night field duties, was practically impossible. Mining activities also require the use of many dangerous chemicals that have a high tendency to cause occupational fatigue due to their exposure. Among the lifestyle-related factors they complained about, the only one that contributed significantly to their occupational fatigue was a lack of regular physical exercise involving aerobics and muscle strengthening. Mining workers spend the greater part of their time at work and, therefore, have limited time available to them to engage in such physical activities. The general health-related factors that contributed significantly to occupational fatigue among the workers were experience of sleep deprivation and experience of psychological problems. Although the experience of psychological symptoms was significantly linked to the worker's occupational fatigue, it did not impact on their functioning. None of the participants smoked cigarettes or cannabis. Overall, exposure to poor lighting, poor air circulation, not engaging in any form of exercise, sleep deprivation, and experience of psychological symptoms were found to be related to occupational fatigue.

5.2 Methodological validity

This research has a lot of potential. It is one of the few studies of its kind that has been undertaken among mining workers. The study participants were drawn from AAIL's nine operating departments, which increases the sample's representativeness and, by extension, the study's validity. The PHQ, the AUDIT C, and the ASSIST were used to collect data, as were the widely used standard CFQ, the NIOSH generic occupational stress questionnaire, the PROMIS sleep disturbance questionnaire, the PHQ, the AUDIT C, and the ASSIST. To reduce potential biases, appropriate sampling techniques were used. The questionnaires utilized were self-administered, which gave the participants more confidence. The managing director of the mining company, where the study was done through the human resource department, granted permission. All research assistants were properly trained to assist with the administration of the questionnaire. The most difficult aspect of the project was persuading individuals to participate in all of the shift systems. This problem was solved by extending the sample collection time so that workers may complete their shift cycle, including the day shift, in order to participate in the data collection, which was done throughout the day.

5.3 Comparison with previous studies

The study compares favorably to previous research. The occupational fatigue prevalence, 9.1% found in this study is low when compared to 22% in the general population (Loge et al., 1998) and 46% in COVID-19 non-hospitalized patients (Stavem et al., 2021) in Norwegian studies utilizing the Chalder Fatigue Scale with a cut-off of 4 to signify occupational fatigue. Similarly, an Iranian study by Khoshakhlagh et al., (2017), found a greater prevalence of occupational fatigue of approximately, 14.8% among workers of copper extraction industry who utilized the Piper chronic Fatigue Scale. Rachmawati et al., (2020), found a much greater occupational fatigue prevalence (about 54.6%) among underground miners in Indonesia. The wide range of occupational fatigue prevalence revealed in various studies clearly demonstrates that occupational fatigue exposures differ among various populations with different risk factors.

The findings of this study show that there was no significant association between department category of respondents and occupational fatigue, contrary to the popular notion that workers in mining-related departments report occupational fatigue more frequently than those in non-mining related departments. A study among Ghanaian mining department shift workers (Asare et al., 2013), in which respondents' occupational fatigue was measured without the use of a standard fatigue scale, contradicted the findings of this study. Respondents said their occupational fatigue was due to something specific about their job, most likely their department category. Respondents' occupational fatigue determination in the study by Asare et al., (2013) was based on their perspective. A cohort study of fatigue at work and psychological distress across occupations in the Netherlands (Bultman et al., 2001) agreed with the individual level risk factors' (engaging in exercise and experiencing psychological symptoms) association with responder fatigue in this study. Use of occupation and, for that matter, department category alone as a proxy indicator for association with respondent's occupational fatigue, according to Ute Bültmann et al, 2001, was insufficient. As demonstrated in this study, additional information concerning the respondent's perceived work environmental risk factors (for example, insufficient light, poor air circulation, and exposure to toxic substances) at the individual level was required. The lack of a significant association between a respondent's department and their occupational fatigue could be attributed to the study's use of a standard fatigue scale and individual differences in risk factor exposure.

This study reveals that occupational fatigue among the respondents was associated with work environment stress factors, including poor light, poor air circulation and dangerous substances. Working under poor lighting environment had a significant association with respondent's fatigue. The strong correlation between respondent occupational fatigue and low lighting in work areas is similar to findings from a Taiwanese study (Tang et al., 2016) that looked at the relationship between persistent fatigue and job-related psychological stress among industrial workers. The reasons for respondent's occupational fatigue could be frequent visual demand tasks under poor lighting conditions leading to eye fatigue and consequently, psychological fatigue (Králiková et al., 2021). In this study, poor air circulation was significantly associated with respondent's occupational fatigue. The findings were similar to those of studies conducted in Austria (Vogt and Krenn, 2007) on the working conditions of employees and pensioners, as well as in older men in Boston (Mehta et al., 2015) on the relationship between air pollution and perceived stress, a contributor to fatigue. Occupational fatigue among study participants was most likely due to long-term exposure to high levels of stress factors, such as air pollution at work due to poor air circulation (Petrowski et al., 2021). A previous study reported on the effect of work environment dangerous substances on work environmental stress (Lu et al., 2020). According to (Leka and Aditya, 2010)., exposure to dangerous chemical substances can have a psychological impact on workers due to their brain, the unpleasantness of their odor, and the worker's fear that such exposure will have a negative health impact, including fatigue. Surprisingly, this study found no link between hazardous substance exposure and occupational fatigue among respondents. This could be an indication that the exposures were so well controlled that they did not elicit enough work stress among the respondents to have a significant impact on their occupational fatigue, as revealed in this study.

Factors that were related to general health, such as the experience of psychological symptoms (depression), were significantly associated with occupational fatigue among respondents in this study. The findings was supported by a study conducted in Germany among the working population to determine the unique impact of work environment stressors on fatigue (Rose et al., 2017). With the course of 4 years, a randomized trial of 151 fatigued employees found that depression and occupational fatigue were substantially linked over time. The findings also revealed that the link between the two could become more entwined with time (Huibers et al., 2007). Long working hours exceeding 8 hours/day or 40 hours/week, as well as sleep deprivation, were revealed to be independent factors linked with the prevalence of depressive symptoms in a previous study conducted in China with 3589 participants (Liu et al., 2021). Although shift work was not significantly associated with occupational fatigue in the bivariate analysis, with the characteristic long working hours of the mining industry, it is likely to have had a consequential impact on respondents' psychological symptoms (depression). This could explain the significant association of respondents' experience of psychological symptoms with occupational fatigue in the multivariable analysis.

In this study, respondents' levels of occupational fatigue were significantly associated with lifestyle factors, such as sleep deprivation and a lack of physical activity lasting up to 30 minutes per day for at least 5 days per week. The significant association of experience of sleep deprivation with occupational fatigue in this study is consistent with previous research in industries with extended working hours, such as the mining industry. A Chinese study that investigated the effect of long working hours on employees' depressive symptoms discovered that sleep deprivation, sometimes caused by insomnia, prolonged occupational fatigue among workers of small scale internet companies (Liu et al., 2021). Another study that used facial cues to examine the effect of sleep deprivation on fatigue in women found a strong association between sleep deprivation and fatigue (Sundelin et al., 2013). A combination of early morning awakenings and long working hours, which is uncommon in other industries, could have contributed to the significant association of sleep deprivation with occupational fatigue among this study's respondents (Legault., 2011). Studies done among people from the general working population in Denmark (Bláfoss et al., 2019) support the occupational fatigue associated with a lack of physical exercise lasting up to 30 minutes per day for at least 5 days a week or any sort of physical activity during the week. Adults who spent more time at work, with little time for leisure and no time to exercise, reported higher levels of occupational fatigue. A longitudinal online study of industry workers in Japan found a link between long hours of sedentary work that limited physical activity in response to the COVID-19 pandemic and fatigue (Mohammad et al., 2021). Exercise has been shown to significantly increase energy levels and decrease occupational fatigue (Puetz et al., 2006). Significant fatigue was observed among those who did not engage in any physical activity. This could be because they worked longer hours, leaving no time for low-intensity aerobic exercise, which has been shown to increase workers' energy levels by reducing occupational fatigue by 65 % (Puetz et al., 2008).

5.4 Study limitations

There are some limitations to this study. The questionnaire was only administered to workers in the AngloGold Ashanti Iduapriem mine, therefore the results cannot be easily extended to other mining industries or their health and safety contexts, but they can be duplicated. Another limitation of the study was the lack of inclusion and analysis of other exposures, such as family-work conflicts and job load, which could have influenced the participants' fatigue. As a result, future studies should consider the influence of other probable exposures of occupational fatigue. The cross-sectional design nature of the research imposes standard limitations of cause and effect inference. More research with longitudinal data is needed to evaluate the impact of occupational fatigue in the workers and develop effective interventions.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Occupational fatigue was prevalent in nearly one out of every ten workers at the AngloGold Ashanti Iduapriem mine in Tarkwa who participated in this study. It was surprising to discover that there was no significant association between participants' sociodemographic factors and their fatigue. The findings suggest that work environment stress factors that contributed significantly to the participants' fatigue were poor lighting and air circulation. General health-related factors, including sleep deprivation and psychological problems, played significant roles in the fatigue status of participants. The lifestyle factors, such as a lack of any form of exercise, including aerobics, contributed significantly to participants' occupational fatigue. According to this cross-sectional study, work environment stress factors, general health-related factors, and lifestyle-related factors were the significant risk factors for occupational fatigue among the participants.

6.2 Recommendations

In subsequent studies, the influence of other probable factors of occupational fatigue such as family-work conflicts and job load, can be considered. A longitudinal study using the baseline findings from this study on the respondents will aid in determining the effects of occupational fatigue in workers and developing appropriate interventions.

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APPENDIX A

RISK FACTORS OF FATIGUE AMONG WORKERS AT ANGLOGOLD ASHANTI IDUAPRIEM MINE, TARKWA

QUESTIONNAIRE NO: …………………… DATE: ……………………

RESPONDENT'S DEPARTMENT OF OCCUPATION: *Please tick the box against your department*

1. Geology □ **2. Mining** □ **3. Processing** □ **4. Finance** □ **5.HR** □

6. HSE □ **7. Sustainability** □ **8. Security** □ **9. ENGINEERING** □

SECTION A: SOCIO-DEMOGRAPHIC CHARACTERISTICS

NO.	QUESTION	CODE
1	Age……………………….years	AGE
2	Sex 1. Male □ 2. Female □	SEX
3	Marital Status: 1. Married □ 2. Single	MARITAL
4	Highest educational level 1. Tertiary □ 2. Secondary □ 3. Middle/JSS □ 4. Primary □ 5. No education □ 6. Other, specify………………	EDU

SECTION B WORK-ENVIRONMENT STRESS FACTORS

Exposure to physical environment. To what extent are each of the following statements describing your exposure to the physical environment. Use the response category Never, Sometimes and Always.

NO.	QUESTION	CODE
8	The level of **noise** in the area(s) in which I work is usually high. 1. Yes □ 2. No □	NOISE
9	The level of **lighting** in the area(s) in which I work is usually poor. 1. Yes □ 2. No □	LIGHT
10	The **temperature** of my work area(s) is usually **cold**. 1. Yes □ 2. No □	TEMP_COLD
11	The **temperature** of my work area(s) is usually **hot**. 1. Yes □ 2. No □	TEMP_HEAT
12	The level of **vibration** in my work area(s) is usually high and unbearable 1. Yes □ 2. No □	VIBRATION
13	The level of **air circulation** in my work area(s) is poor. 1. Yes □ 2. No □	AIR_CIRCUL
15	In my job, I am exposed to **dangerous substances** (e.g. radiation, chemicals, gases, dust, fumes, etc.). 1. Yes □ 2. No □	DANGER_SUBS
16	The overall quality of the **physical environment** where I work is poor. 1. Yes □ 2. No □	PHY_ENV
17	My **work area(s)** is/are awfully crowded. 1. Yes □ 2. No □	WORK_AREA
18	Select the description that comes closest to your present **WORK SHIFT**: 1. Eight-hour day shift □ 2. Ten-hour day shift □ 3. Rotating 12-hour day and night shift □ 4. Ten-hour day shift with on-call duties □	WORK_SHIFT
5	How long have you worked with AAIL? Years ………………… Months ……………….	LENGTH_SERV
6	Averagely, how long does it take you to get to work each day? ………………hour(s) and ………………… Minutes	COMMUTE_TIME

SECTION C GENERAL HEALTH-RELATED FACTORS

A. Sleep disturbance/deprivation. Please respond to each question or statement by marking one box per row.

NO	SITUATION	RESPONSE					Score	CODE
	In the past seven (7) days							
		Not at all	**A little bit**	**Somewhat**	**Quite a bit**	**Very much**		
19	My sleep was restless	□ 1	□ 2	□ 3	□ 4	□ 5		Sleep _dist
20	I was satisfied with my sleep.	□ 5	□ 4	□ 3	□ 2	□ 1		
21	My sleep was refreshing.	□ 5	□ 4	□ 3	□ 2	□ 1		
22	I had difficulty falling asleep.	□ 1	□ 2	□ 3	□ 4	□ 5		
	In the past seven (7) days							
		Never	**Rarely**	**Sometimes**	**Often**	**Always**		
23	I had trouble staying asleep	□ 1	□ 2	□ 3	□ 4	□ 5		
24	I had trouble sleeping.	□ 1	□ 2	□ 3	□ 4	□ 5		
25	I got enough sleep.	□ 5	□ 4	□ 3	□ 2	□ 1		
	In the past seven (7) days							
		Very poor	**Poor**	**Fair**	**Good**	**Very good**		
26	My sleep quality was...	□ 5	□ 4	□ 3	□ 2	□ 1		

During the past MONTH, how many HOURS OF ACTUAL SLEEP DID YOU GET PER NIGHT? ……

B. Psychological symptoms. Over the last 2 weeks, how often have you been bothered by any of the following problems? *(Use "✔" to indicate your answer)*

NO.	SITUATION	RESPONSE				Score	CODE
		0 Not at all	1 Several days	2 More than half the days	3 Nearly every day		
27	Little interest or pleasure in doing things	□	□	□	□		Psych_symptoms
28	Feeling down, depressed, or hopeless	□	□	□	□		
29	Trouble falling or staying asleep, or sleeping too much	□	□	□	□		
30	Feeling tired or having little energy	□	□	□	□		
31	Poor appetite or overeating	□	□	□	□		
32	Feeling bad about yourself — or that you are a failure or have let yourself or your family down	□	□	□	□		
33	Trouble concentrating on things, such as reading the newspaper or watching television	□	□	□	□		
34	Moving or speaking so slowly that other people could have noticed? Or the opposite — being so fidgety or restless that you have been moving around a lot more than usual	□	□	□	□		
35	Thoughts that you would be better off dead or of hurting yourself in some way	□	□	□	□		

If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?

Not at difficult all □ Somewhat difficult □ Very difficult □ Extremely difficult □

SECTION D LIFESTYLE FACTORS

Please for each question tick the box with the option that applies to you.

No	Question	0	1	2	3	4	Score	CODE
36	How often do you have a drink containing alcohol?	Never ☐	Monthly or less ☐	2 to 4 times per month ☐	2 to 3 times per week ☐	4 or more times per week ☐		ALCOHOL_CONSUMP
37	How many units of alcohol do you drink on a typical day when you are drinking?	0 to 2 ☐	3 to 4 ☐	5 to 6 ☐	7 to 9 ☐	10 or more ☐		
38	How often have you had 5 or more units of the drink on a single occasion?	Never ☐	Less than monthly ☐	Monthly ☐	Weekly ☐	Daily or almost daily ☐		
39	During the past 3 months, how often have you smoked cigarette, Cannabis (marijuana), etc?	Never ☐	Once or twice ☐	Monthly ☐	Weekly ☐	Daily or almost daily ☐		SMOKING
40	In the past 3 months how often have you used drugs (eg. *cannabis (marijuana), cocaine, narcotic pain medications, sedatives (benzodiazepines) or stimulants (amphetamines)* other than those required for medical treatment?	Never ☐	Once or twice ☐	Monthly ☐	Weekly ☐	Daily or almost daily ☐		SUBS_INTAKE
41	In the past 3 months how would you rate your overall habits of eating healthy foods?	Excellent ☐	Very good ☐	Good ☐	Fair ☐	Poor ☐		DIET
42	In the last 3 month how often have you engage in physical activity involving aerobics and or muscle strengthening?	At least 30 minutes a day for 5 days ☐	Up to 20 minutes a day for 3 to 4 days ☐	Two to three times a week ☐	Some form of exercise but irregular ☐	Not at all ☐		EXERCISE

SECTION E. FATIGUE CHARACTERISTICS

Please for each question tick the box with the option that applies to you.

Description	Participant's response			
	Less than usual	No more than usual	More than usual	Much more than usual
Do you have problems with tiredness?	☐	☐	☐	☐
Do you need to rest more?	☐	☐	☐	☐
Do you feel sleepy or drowsy?	☐	☐	☐	☐
Do you have problems starting things?	☐	☐	☐	☐
Do you lack energy?	☐	☐	☐	☐
Do you have less strength in your muscles?	☐	☐	☐	☐
Do you feel weak?	☐	☐	☐	☐
Do you have difficulties concentrating?	☐	☐	☐	☐
Do you make slips of the tongue when speaking?	☐	☐	☐	☐
Do you find it more difficult to find the right word?	☐	☐	☐	☐
	Better than usual	No worse than usual	Worse than usual	Much worse than usual
How is your memory?	☐	☐	☐	☐

APPENDIX B

If you want further clarification on ethical issues and your rights as a research participant, you can contact the Ghana Health Service Ethics Committee Administrator, Nana Abena Apatu, 0503539896, ethics.reseach@ghsmail.org

CONSENT FORM

TITLE OF THE STUDY: RISK FACTORS OF FATIGUE AMONG WORKERS AT ANGLOGOLD ASHANTI IDUAPRIEM MMINE, TARKWA

PARTICIPANTS' STATEMENT

I acknowledge that I have read or have had the content sufficiently described to me in a language I understand (English/ Twi) the purpose and contents of the Participants' Information Sheet. I am fully aware of the contents and any potential consequences, as well as my right to change my mind (i.e. withdraw from the study) even after signing this form.

I voluntarily agree to be part of this study

Name or initials of participant……………………………………..
Participant signature……………………………... or Thumb print…………………………

Date ………………………………….

INTERPRETER'S STATEMENT
To the best of my ability, I interpreted the purpose and contents of the Participants' Information Sheet into Twi for the aforementioned participant's correct understanding.
All questions, suitable clarifications, and answers were duly translated to the participant's satisfaction.
Name of interpreter: …………………………………………... Signature……………….

Date: ……………………………………... Contact details:
STATEMENT OF WITNESS
I was present when the purpose and contents of the Participant Information Sheet were read to the participant and sufficiently described in the language he or she understood (English / Twi).
I confirm that he/she was given the chance to ask questions or seek clarifications, and that such questions/clarifications were promptly answered to his/her satisfaction prior to freely choosing to participate in the study.

Name: ……………………………………………………………………………………….

Signature: ………………………………………. Thumb print………………………

Date: ……………………………

INVESTIGATOR STATEMENT OR SIGNATURE

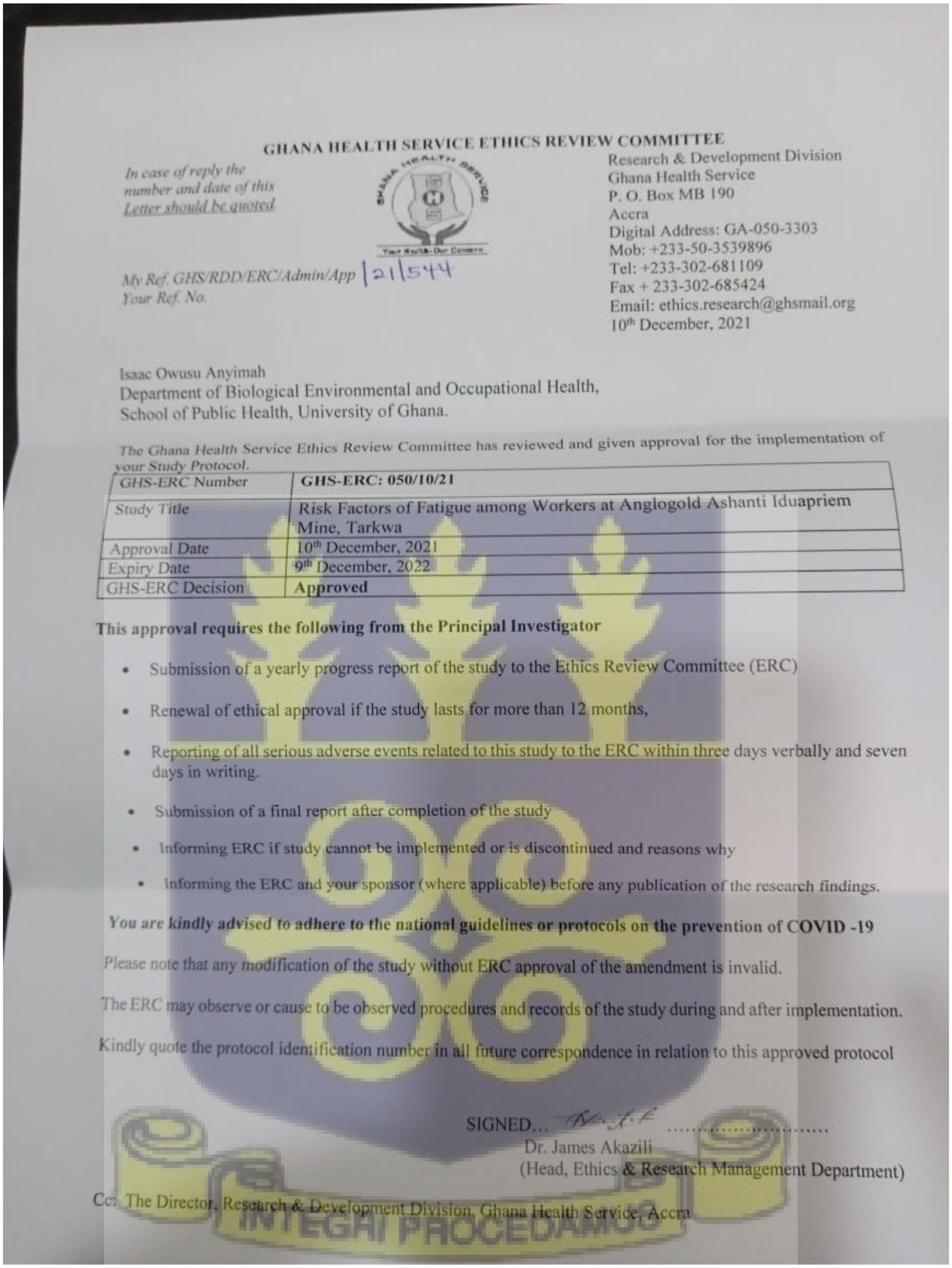
I certify that the participant was given sufficient time to read and understand the study. All of the participant's queries and concerns have been addressed.

Researcher's name: ………………………………………………………..

Signature: ……………………………………………

Date: ………………………………………………….

APPENDIX C



GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this Letter should be quoted.

My Ref. GHS/RDD/ERC/Admin/App /21/544
Your Ref. No.

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Digital Address: GA-050-3303
Mob: +233-50-3539896
Tel: +233-302-681109
Fax + 233-302-685424
Email: ethics.research@ghsmail.org
10th December, 2021

Isaac Owusu Anyimah
Department of Biological Environmental and Occupational Health,
School of Public Health, University of Ghana.

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	**GHS-ERC: 050/10/21**
Study Title	Risk Factors of Fatigue among Workers at Anglogold Ashanti Iduapriem Mine, Tarkwa
Approval Date	10th December, 2021
Expiry Date	9th December, 2022
GHS-ERC Decision	**Approved**

This approval requires the following from the Principal Investigator

- Submission of a yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report after completion of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.

You are kindly advised to adhere to the national guidelines or protocols on the prevention of COVID -19

Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED…………………………
Dr. James Akazili
(Head, Ethics & Research Management Department)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra