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Occupational Health Hazards among Large-Scale Gold Mineworkers in Ghana

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Abstract

Introduction: The mining industry ranks among the most hazardous occupations globally owing to the high prevalence of workplace accidents. To better protect workers in the industry, there is a need for a comprehensive understanding of risk factors, common illnesses and provision of PPE. **Objective:** This study examined the prevalence and underlying risk factors to work-related injuries, common illnesses, and Personal Protective Equipment (PPE) usage among mineworkers in two large-scale mining companies in Ghana that consented to participation. **Methodology:** Two hundred mineworkers were selected through stratified sampling in these companies using a semi-structured questionnaire. Chi-square test and binomial logistic regression were employed to determine the relationship between the incidence of occupational injury and selected risk factors using R studio. **Results:** The results showed that more than a tenth (16%; n = 31) of mineworkers had sustained physical injuries since being employed—mostly lacerations (53%). Out of those injured, (85%; n = 22) reportedly sustain an injury annually. A little more than half (57%; n = 112) of the mineworkers work for more than 40 hours per week. Injuries were significantly associated with the type of profession at the mine (p = 0.04; χ^2 = 4.3)—Technicians and Mechanics were more likely to be injured. Although not statistically significant, working for more than 40 hours/week doubled the odds of being injured at the workplace (aOR = 1.77; 95% CI: −0.27 - 1.48). The topmost illnesses among mineworkers were musculoskeletal pains (MSPs) [53%] and headaches (35%). About two-thirds (65%) had all the needed PPEs for their work. Safety goggles were the predominant PPE reportedly lacking among the mineworkers (16%; n = 31). **Conclusion:** There is a need for targeted training/intervention programmes and adoption of assistive ergonomic devices to protect mineworkers.

Keywords

Occupational Health, Safety, Gold Mining, Injury, Illnesses, Ghana

1. Introduction

The mining industry plays a pivotal role in the social and economic development of many mineral-rich countries worldwide [1] [2]. Particularly in low- and middle-income mineral-rich countries, the industry attracts significant foreign direct investment (FDI) and rakes in substantial export revenues to boost economic growth [3]. For instance, in Botswana, Sierra Leone, DR Congo and Mongolia, the mining industry accounts for up to 90% of all export revenues [4]. Ghana is a key player in the mining industry on the African continent and occupies the top spot for gold production. Therefore, the growth of the Ghanaian economy is inextricably linked to the mining industry as it provides more than a third of all export revenues and more than half of all foreign direct investment [5].

However, mining operations usually come with grave environmental and public health risks. The International Labour Organisation classifies mining as the most hazardous occupation, considering the number of people exposed to the various work-related risks [6]. Globally, the mining industry employs only 1% of the global workforce, but 8% of all fatal workplace accidents occur in this industry [6]. Moreover, apart from the high prevalence of fatalities, mineworkers are exposed to numerous physical, chemical, and other health hazards by their work [7] [8] [9] [10]. These leave them with long-term diseases, including musculoskeletal disorders and respiratory diseases [7] [8] [9] [10].

Protecting workers from workplace accidents and injuries is crucial for productivity and economic development. This is a critical component of the United Nations' Sustainable Development Goals. Specifically, Target 8.8 of SDG 8 seeks to protect labour rights and promote safe and secure working environments for all workers, including migrant workers, particularly women migrants, and those in precarious employment [11]. To guide the formulation of policies that will ensure the adoption of practical measures and to prevent occupational injuries among miners, it is imperative to conduct comprehensive studies on the characteristics of work-related illnesses and injuries and their underlying factors and PPE usage. However, generally, there is a lack of literature on occupational health and safety issues, particularly in the developing world. For instance, in Ghana, a cursory assessment of earlier studies focusing on the mining sector shows a lopsided distribution towards the environmental impacts of mining.

Furthermore, available studies on occupational health and safety in the mining sector only focused on the small-scale and informal mining sector [12] [13] [14] [15]. To extend the current boundary of existing knowledge and address the existing gap, this study assesses occupational health and safety practices among mineworkers in the large-scale mining sector in Ghana. The study explicitly

examines the incidence and underlying risk factors to work-related injuries, common illnesses, and PPE usage among mineworkers. These findings will significantly advance the understanding of occupational hazards, injuries and illnesses amongst large scale mineworkers and help identify several intervention points.

2. Materials and Methods

Study areas

The study population comprised all mineworkers in two out of fourteen legally registered large-scale mining companies in Ghana's Western and Central Regions: Anglogold Ashanti (Iduapriem Limited) and Perseus Mining (Ghana) Limited. The two companies were the only ones that showed willingness to participate in the study.

Anglogold—Ashanti, Tarkwa branch is situated in the Iduapriem Township of the Tarkwa Nsuaem Municipal Area of the Western Region of Ghana. The mine site is about 70 km north of Takoradi and 10 km southwest of Tarkwa. Iduapriem is an open-pit mine with two circuits, each comprising two-stage milling—a gravity circuit and a carbon-in-leach (CIL) plant. The gravity circuit recovers about 30% of the gold, and the remainder is recovered by the 418 ktpm capacity CIL plant (Anglogold Ashanti Limited, 2020).

Perseus Mining (Ghana) Limited is one of the several mining companies in Ghana located at Ayanfuri. The company operates the Edikan Gold Mine (EGM)—a large-scale, low-grade multi open-pit operation situated on the prolific Ashanti Gold Belt, with a gold endowment of more than 170 million ounces [16]. The EGM is a conventional open-pit mining operation where operations such as grade control, drill and blast, load and haul and dewatering are undertaken. Ore is sourced from 5 open pits. The processing facility at EGM consists of single-stage crushing, semi-autogenous grinding (SAG) milling to P_{80} 212 μm, gravity, sulphide floatation, sulphide regrind to P_{80} 45 μm and carbon-in-leach (CIL) recovery [17]. Depending on the ore hardness, the plant processes between 6.5 and 7.0 Mtpa [17].

Study design

This was a descriptive cross-sectional study. The two large-scale mining companies were selected based on their willingness to participate in the study. However, stratified sampling technique was employed to collect data from 200 employees of these companies out of an anticipated 384 respondents. Since data on the population of workers were not made available, Cochran's formula was used to estimate the sample size.

$$n = \frac{z^2(p)(1-p)}{c^2}$$

z = standard normal deviation set at 95% confidence level (1.96)

p = percentage picking a choice or response (50% = 0.5)

c = confidence interval at 5% = 0.05

$$n = \frac{1.96^2 (0.5)(1-0.5)}{0.5^2} = 384$$

The selection approach ensured all professions in the mining industry had an equal chance of being involved in the study. The respondents were pre-grouped into five main categories based on their work type and the stratified selection ensured that all professions were involved (Table 1). The difficulty in getting participants for the research due to the busy schedules of the mineworkers during data collection hampered the selection of a larger sample size. Some respondents had to end midway through the face-to-face questionnaire administration abruptly. Data collection at the mine sites was also limited to only selected days of the week based on instructions from mine authorities and therefore overly prolonged the data collection phase of the research. The data collection phase was initially planned for three weeks, but eventually, it was done over a four-month period with up to twice per week visit to the mining sites permitted.

Data collection

Data were collected using trained Field Assistants employing structured questionnaires in English. However, where necessary, Field Assistants translated the questionnaire into the local language (Twi) while avoiding misinterpretation of the questions. Two Field Assistants with prior data collection experience were used for the data collection and trained over three days by the authors. The questionnaire was divided into four sections to capture information on socio-demographic characteristics, job characteristics, work-related injuries, common illnesses experienced by the mineworkers and use of PPE. Before the actual data collection, the questionnaire was pre-tested with twenty respondents in total, ten from each mining company. This allowed the researchers to modify certain questionnaire items appropriately. Specifically, questions on access to PPE at the workplace and common illnesses experienced were modified to suit the conditions at the mine sites.

This research adhered to all the necessary ethical requirements. Verbal consent was sought from all respondents before the questionnaire administration. All respondents were informed of the purpose of the study and its objectives.

Table 1. Categories of mineworkers involved in the study.

Job categories	Type of workers classified under the job category
Technician	Equipment operators, Pit technician, Tyre Technician, Electrician,
Non-technical staff	Cleaners, Security Personnel, Receptionist, Driver, ICT Personnel
Mechanic	Pump Mechanics, Welders, Drill mechanics, Auto Mechanics, Plumbers, Sprayers
Engineer	Civil Engineers, Geologists, Metallurgists, Electrical Engineers, Mechanical Engineers, Geotechnical Engineers, Project Engineers
Technical Staff	Maintenance supervisors, Blast monitors, Health and Safety Officers, Environmental Rehabilitation Supervisors, Environmental Monitoring Officers, Samplers

Respondents were informed that participation in this study was voluntary and that they had the right to withdraw from the research or withhold any information they were not comfortable sharing. They were also assured of the confidentiality of their narratives and personal identities.

Data analysis

After the data collection, the data were coded and cleaned in Microsoft Excel (2016) and R studio was used for analysis. Descriptive and statistical analyses of the data were conducted with R studio (Version 1.4.1717). Therefore, the missing data were not included in the descriptive statistics.

First, chi-square test was used to determine associations between injury incidence and selected study variables. Using this approach, all responses to the dependent and independent variables were coded using the binary codes; 0 and 1.

A p-value ≤ 0.05 was considered statistically significant. Variables that are statistically significantly associated with physical injury and those with p-values less than 0.1 were subsequently included in the multivariate binomial logistic regression.

Binomial logistic regression was used to determine the relationship between the incidence of occupational injury and selected socio-demographic and work-related parameters. Listwise deletion was used to remove all data for a case with one or more missing values.

The adjusted odds ratio (aOR) was computed from the coefficient to determine precisely how it contributed to work-related injuries. The R-code, questionnaire and the data used in this study can be found through this link: https://bit.ly/3D58RHg.

3. Results

Demographic characteristics of study respondents

Table 2 shows the demographic characteristics of the respondents involved in the study. More than four out of five (85%) respondents were males, while close to two-thirds (64.5%) were within the youthful age bracket of 18 - 35 years. In addition, almost one out of every two respondents (43%) had tertiary education, and a little more than half (58%) were married.

The dominant job category among the mineworkers was Technicians. This constituted almost 2 out of every 5 (37.5%) respondents, while about a third (29.5%) of respondents were Non-technical staff. About 4 out of 5 mineworkers interviewed during the study had up to 6 years working experience. This indicates that most of the mineworkers were recently employed. In terms of working hours, the study found that less than half (44%) of the mineworkers have a regular 8-hour shift daily which sums up to 40 hours per week. On the other hand, most of the mineworkers (56%) work for more than 40 hours per week.

Close to 9 out of every ten mineworkers had been given on-the-job training since employment. Training before and after being hired, plays a critical role in promoting health and safety awareness among employees (Table 3).

Table 2. Demographic characteristics of study respondents (N = 200).

Study parameter	Variables	Frequency (n)	Percentage (%)
Gender	Females	31	15.5
	Males	169	84.5
Age group (years)	18 - 25	31	15.5
	26 - 35	98	49
	36 - 45	54	27
	More than 45	17	8.5
Highest educational level	Primary School	2	1
	JHS/MSLC	30	15
	Senior High School	83	41.5
	Tertiary Education	85	42.5
Marital status	Single	77	38.5
	Married	116	58
	Divorced/Separated	6	3
	Widowed	1	0.5

Table 3. Work-related characteristics of respondents.

Study parameter	Variables	Frequency (n)	Percentage (%)
Job category	Technician	75	37.5
	Non-technical staff	59	29.5
	Mechanic	38	19
	Engineer	15	7.5
	Technical Staff	13	6.5
Work experience (years)	0 - 2	60	30.2
	3 - 4	54	27.1
	5 - 6	47	23.6
	7 - 8	23	11.6
	9 - 10	4	2.0
	More than 10	11	5.5
	Missing data	1	-
Working hours per week	Up to 40 hours	87	43.7
	40 to 60 hours	86	43.2
	60 to 80 hours	11	5.5
	More than 80 hours	15	7.5
	Missing data	1	-

Continued

	Yes	172	87.8
On-the-job training	No	24	12.2
	Missing data	3	-

Table 4 presents the distribution of work-related injuries sustained by the mineworkers. Less than one-fifth (16%) of the mineworkers reported being injured at work since their employment. When asked about the type of injury sustained, more than half (53%) of the workers reported laceration. Some workers, although reported being injured, did not give details of their injury—they did not want to recollect painful memories from the past. About four out of five (85%) of these mineworkers sustain an injury each year at the workplace, while quite a few (15%) sustain multiple injuries in a year.

The results of the chi-square test (Table 5) showed that gender, age, level of education, marital status, work experience, on-the-job training and weekly working hours are not responsible for physical injuries at the workplace. However, the job category ($p = 0.04$; $\chi^2 = 4.30$) is significantly associated with physical injury at work. This indicates that Technicians and Mechanics are more likely to suffer from work-related injuries. About two-thirds (65%) of mineworkers who had sustained work-related physical injuries were Technicians or Mechanics. A worrying trend observed from the chi-square test was a statistically significant association between work experience and weekly working hours. Newly recruited mineworkers (up to five years working experience) usually work for more than 40 hours per week compared to those with more than five years working experience ($p = 0.02$; $\chi^2 = 5.4$).

Two parameters were used in the multivariate binomial logistic regression; weekly working hours and job category. Per the regression (Table 6), although not statistically significant, working more than 40 hours per week doubled the odds of physical injury at work (aOR = 1.77; 95% CI: −0.27 - 1.48). About 3 out of every four (71%) mineworkers who had sustained occupational injury worked for more than 8 hours per week (Table 5). Moreover, Technicians and Mechanics were twice more likely to sustain physical injury compared to other job categories (aOR = 1.97; 95% CI: −0.13 - 1.53). This was however not statistically significant.

The distribution of commonly experienced illnesses is shown in Figure 1. Generally, musculoskeletal pains (MSPs) dominated the common illnesses experienced by the mineworkers. Ninety mineworkers reported experiencing this illness. This was closely followed by headaches, reported by 60 mineworkers. These illnesses constituted the two topmost illnesses experienced by the mineworkers. Musculoskeletal pains among the mineworkers are to be expected owing to the physical exertions that form part of their work.

A cross-tabulation of the two topmost illnesses with job type (Figure 2) showed that Technicians usually suffer from musculoskeletal pains and

Table 4. Incidence of work-related injuries.

Study variables		Frequency	Percentage (%)
Injured at work since employment	Yes	31	15.8
	No	165	84.2
	Missing data	4	
Type of injury	Laceration	9	52.9
	Sprain	4	23.5
	Crushed finger	2	11.8
	Electrical shock	1	5.9
	Fracture	1	5.9
	Missing data	14	
Annual injury frequency	Once	22	84.6
	Multiple times	4	15.4
	Missing data	5	

Table 5. Association between work-related injury and selected parameters.

Study variables		Injured during work		p-value (χ^2)
		No (n = 165)	Yes (n = 31)	
Gender	Male	139	27	0.69 (0.16)
	Female	26	4	
Age group	Up to 35 years	112	21	0.47 (0.52)
	More than 35 years	53	10	
Highest level of education	Up to SHS	96	16	0.50 (0.46)
	Tertiary	69	15	
Marital status	Single	62	11	0.43 (0.61)
	Married/Widowed Separated/Divorced	103	20	
Working hours per week	Up to 40 hours	77	9	0.07 (3.30)
	More than 40 hours	87	22	
Work experience (years)	Up to 5 years	114	23	0.60 (0.27)
	More than 5 years	50	8	
Job category	Engineer/Non-Technical/ Staff Technical Staff	92	11	0.04 (4.30)*
	Technician/Mechanic	73	20	
On-the job training received since employment	No	21	4	0.94 (0.01)
	Yes	141	27	

*Statistically significant association with work-related injuries.

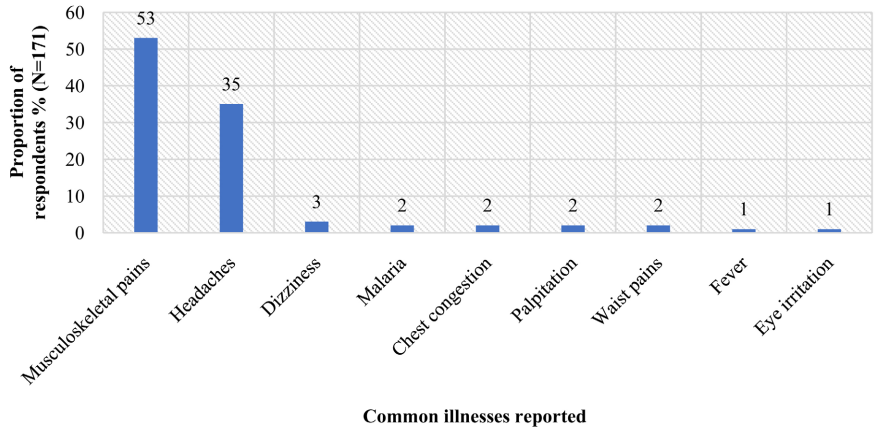

Figure 1. Common illnesses experienced by mineworkers.

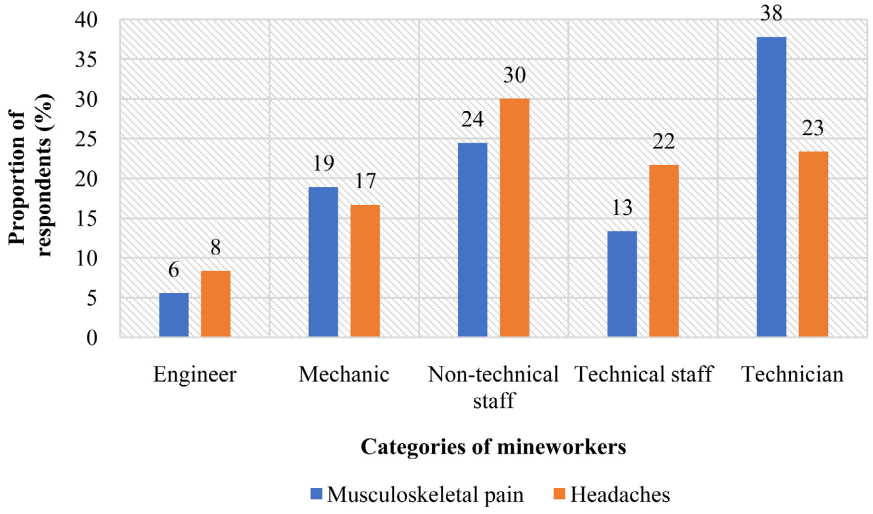

Figure 2. Distribution of the two topmost illnesses by job categories.

Table 6. Relationship between physical injury, job category and weekly working hours.

Independent variables	β	SE	p	aOR	95% CI
Job category	0.6798	0.4218	0.107	1.97	−0.13 - 1.53
Weekly working hours	0.5736	0.4419	0.194	1.77	−0.27 - 1.48

headaches. About two out of five (38%) of all reported musculoskeletal pains were by Technicians. This is followed by Non-Technical staff who reported about a quarter (24%) of musculoskeletal pains. Similarly, close to a third (30%) of all reported headaches were by Non-Technical staff, and Technicians reported about a quarter (23%) of headaches. Generally, the Non-Technical Staff, Technicians and Mechanics have more physically demanding tasks at a mine site. For example, these workers usually operate equipment or repair them when they break down. Therefore, this finding buttresses the earlier assertion that workers with physically demanding tasks commonly suffer from MSPs.

Overall, almost all (99%) of the respondents from both mining companies correctly indicated the importance of the PPEs commonly used at their workplace. When asked to describe the significance of eight commonest PPEs used at their workplace, all the mineworkers correctly described the importance of five of these PPEs (Table 7). These PPEs were hard hats, nose masks, reflective vests, safety boots and earplugs. Nearly all the respondents were observed to be in some form of PPEs during the survey. This is because, as was gathered through interactions with the respondents, PPEs are strongly enforced in these companies, and there are signposts at vantage points to remind employees to put on the requisite PPEs. These practices seem to be reinforcing the use of PPEs in these mining companies.

Only a tenth of respondents indicated that they had not been provided with any PPE, while close to two-thirds (65%) reported that they had been provided with all the PPEs required for their work (Table 8). Protective eyeglasses (goggles) were the dominant PPE lacking among the mineworkers without fully complementing PPEs. This constituted almost half (44%) of the PPEs, which were unavailable to the mineworkers.

Table 7. Knowledge on importance of PPEs.

PPE	Knowledge on importance	Frequency (n)	Percentage (%)
Gloves	Correctly described	196	98
Hard hat	Correctly described	200	100
Eyeglasses	Correctly described	197	99
Nose masks	Correctly described	200	100
Reflective Vest	Correctly described	200	100
Safety boots	Correctly described	200	100
Earplugs	Correctly described	200	100
Reflective overalls	Correctly described	198	99

Table 8. Provision of PPEs to the mineworkers.

Parameters	Variables	Frequency	Percentage (%)
PPEs Provided	All PPE provided	129	64.5
	Safety boots only	3	1.5
	Safety boots and reflective shirt	4	2.0
	Uniform, goggles and helmet	30	15.0
	Dust mask/gloves/glasses/ear plugs	14	7.0
	No PPE provided	20	10.0
PPEs lacking	Leather gloves	19	26.8
	Raincoat	21	29.6
	Protective eyeglasses (Goggles)	31	43.7

4. Discussion

The dominance of males within the youthful age bracket in the mining companies involved in the study reflects the widely-held notion that the mining industry remains the most masculine of industries and requires brawn due to the labour-intensive jobs [18] [19]. Due to the physically demanding nature of the position of Mechanics and Technicians, less than a quarter (22%; n = 7) of females (N = 31) were found in these job categories. However, in the informal mining sector, available literature [20] [21] reported that women constitute up to half of the labour force. The educational levels of respondents in the mining companies in this study were relatively higher than those reported in the informal sector. This is contrary to earlier studies [13] [22] conducted in Ghana on artisanal and small scale mineworkers, which reported limited education among these mineworkers. It appears to show that education, perhaps, is a crucial employment criterion in the formal mining sector. In contrast, the informal sector is dominated by less educated individuals looking to earn enough to survive [20].

The distribution of work experience among the mineworkers shows that most of them are new at their work. More than half (57%) of the workers have less than 5 years of working experience. In a study conducted by [23], mineworkers who were new at their jobs were more susceptible to long working hour injuries. Similarly, this study also found that mineworkers with up to five years of working experience are more likely to clock extended working hours, exposing them to occupational injuries. This seems to suggest that newly recruited mineworkers are being overworked.

Working for long hours has been reported, in literature, to cause adverse health effects among workers. For example, epidemiological studies have shown that long working hours can result in heart attack [24] [25]; death [23]; stress [26] [27] [28]; and depression [29]. Moreover, in a systematic review of literature, Salminen [30] concluded that working beyond 12 hours per day increases the risk of occupational injury by more than a third (38%), and this reduces to 15% when compared to those working 8 hours daily. Moreover, available literature [31] [32] reported that mineworkers who worked for more than 8 hours were more likely to be fatigued and lose concentration leading to injury. In line with these findings, this study also showed that working more than 40 hours per week doubled the odds of being injured. To avoid these dangers of long working hours, Section 33 of Ghana's 2003 Labour Act (Act 651) stipulates a maximum of eight hours a day or forty hours a week hours of work except in cases expressly noted in the Act [33]. Per the results of this study, more than half (56%; n = 112) of the mineworkers work for more than 40 hours per week in direct contravention of the provisions of the Act. This is similar to other studies [34] [35], which reported violations of workers' rights at mining sites. Most mineworkers interviewed (96%) reported being granted leave periods (off days) where they are allowed to rest. This fulfils the provisions in Ghana's 2003 Labour Act (Act 651), which entitles employees to not less than fifteen working days leave with full pay

in any calendar year of continuous service. It appears there is a partial adherence to the Labour Act in the mine sites. Therefore, there is a need for enforcement of regulations regarding working hours. Further studies must also be conducted to examine how the long working hours impact the workers' health (particularly non-physical injuries). This will ensure that appropriate weekly working hours can be adopted for the mineworkers while meeting production targets.

The mining industry ranks among industries with physically-demanding jobs. Just like construction workers and firefighters, mine workers are usually exposed to intense and repeated physical exertions. As a result, workers in this industry are prone to musculoskeletal pains. In this study, MSPs dominated the common illnesses reported. This is similar to the existing literature on physically-demanding jobs—construction workers [36], vehicle repair artisans [37], nurses [38] and active-duty military personnel [39] which also reported high prevalence of MSPs. Musculoskeletal pain can be acute or chronic pain that affects bones, muscles, ligaments, tendons, and even nerves [40]. In the mining industry, repetitive kneeling, turning of the waist, squatting, bending the trunk, awkward postures and prolonged standing are common activities [41]. Since these postures form a crucial part of the job of mineworkers, there should be mechanisms to protect them from MSPs. Mineworkers should be taken through ergonomic training to ensure proper body mechanics while at work. A mining site ergonomic programme should be introduced to train mineworkers on safe recommended weight limit for lifting, good body posture, among others. This will go a long way to reduce the risk of injury. Additionally, the use of assistive ergonomic devices and frequent breaks from monotonous, repetitive tasks would help to minimise MSPs among the mineworkers.

Another common illness reported among the mineworkers was headaches. This mirrors the findings reported previously by [42], which found more than two-thirds (67%) of mineworkers (N = 106) having headaches. Generally, headaches and dizziness can result from heat exhaustion and dehydration [42] [43]. There could be the possibility that the mineworkers work in hot environments with minimal hydration. To minimise this, mineworkers must be educated to increase fluid intake, and there should be proper ventilation at mine sites, especially during underground activities. Donoghue *et al.* (2000) recommend that, to avoid heat exhaustion, an air-cooling power of more than 250 W/m^2 must be maintained at all underground work sites.

Contrary to earlier studies [13] [44] [45], which found a low level of knowledge on PPEs and low PPE usage in the small scale and informal mining sector, this study found that the mineworkers have an excellent understanding of the significance of PPEs at the workplace. According to Burke *et al.* [46], training workers to realise and recognise possible health threats motivates them to learn more about such hazards and how to avoid them.

As confirmed in available literature [47] [48] [49] [50], good knowledge of the importance of PPEs, reminders through signages and enforcement of PPE usage

at the workplace promote PPE usage. Personal Protective Equipment (PPEs) serve as the first defensive mechanism against hazards encountered and an effective way to protect workers' health (Tanko and Anigbogu, 2012). They provide protection from noise, falling objects, hazardous chemicals, among others, when they cannot be entirely precluded [51].

Eye protection among mineworkers is crucial because, globally, the mining industry is ranked among the occupations with a high prevalence of work-related eye injuries [52] [53]. Eye injuries in the mining environment can result from dynamite explosions [53] and exposure to dust and chemicals [54]. These hazards are ever-present at a mine site, and therefore all mineworkers need to be provided with safety goggles to protect them. Future research would benefit from a comprehensive study of the prevalence of non-physical injuries, including ocular injury and respiratory diseases, among mineworkers in large scale mining companies. The current study looked at the prevalence of physical injuries, but other aspects of occupational diseases need to be extensively studied to determine their prevalence. Future studies should also examine the stress levels among the different mining job categories and suggest stress management strategies for workers considering the long working hours that some endure. Per the study findings, more than half of the mineworkers work for more than the recommended 40 hours per week. Available studies have shown that long working hours adversely affect workers' health. Therefore, it is vital to investigate how this affects the workers both physically and mentally to ensure that measures are instituted to protect them.

Our study has several strengths. Firstly, categorising the mineworkers into their different job types to determine the common illnesses associated with each job type is a unique study approach that sets this study apart from previous studies. Secondly, data were collected from multiple mining companies instead of a single mining company. Additionally, the cross-sectional approach adopted in this study provides the data required to make inferences about possible relationships between the socio-demographic characteristics and occupational health and safety variables while providing preliminary data to support further research and experimentation. Finally, the mixed-method approach (questionnaire administration and observation) adopted for the study makes the methodology robust since some data obtained through questionnaires were confirmed through field observations.

However, this study was not without limitations. The generalisability of the research findings is limited since the study involved respondents from only two mining companies out of about twenty large scale mining companies. Respondents involved did not respond to all questions needed for the survey resulting in some missing data, albeit few. This reduces the study's statistical power, thereby affecting the ability to draw accurate conclusions.

5. Conclusion

In this study, we identified important underlying risk factors to work-related in-

juries, common illnesses, and Personal Protective Equipment (PPE) usage among mineworkers. There is a noticeable relationship between type of job at the mine site and occupational injuries among mineworkers. Technicians and Mechanics are mainly at a higher risk of work-related injuries and therefore require targeted training to protect them from these injuries. Musculoskeletal pains (MSPs) and headaches were the commonest illness among the mineworkers and showed the categories of mineworkers mostly affected. The study provides insights into the occupational risks mineworkers are exposed to and highlights the need to improve health and safety in the mining sector. To reduce the incidence of MSPs, assistive ergonomic devices, frequent breaks from monotonous, repetitive tasks and training on proper body mechanics are suggested. Further studies focusing on the health effects of extended working hours on the mineworkers particularly focusing on the at-risk professions identified is recommended.

Conflicts of Interest

The authors declare that there are no competing interests in this study.

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