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# Prevalence of Lower Back Pain and Associated Workplace and Ergonomic Factors among Mineworkers in a Nickel Mine, Zimbabwe

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**Abstract:** Lower back pain is a common occurrence among mine workers due to the nature of their work. Globally, workplace (occupational) and ergonomic risk factors have been reported to influence the prevalence of lower back pain among workers. This study aimed to determine ergonomic risk factors associated with lower back pain and associated risk factors (workplace and ergonomics) among mineworkers in a nickel mine in Zimbabwe. A cross-sectional study design was employed, and participants were randomly selected to complete a questionnaire that included the Dutch Musculoskeletal Questionnaire (DMQ). A total of 420 mine workers were interviewed, with the majority being male ($n$ = 259, 61.7%) and aged between 31 and 44 years old ($n$ = 159, 37.9%). The study found that the prevalence of lower back pain was 41.43% ($n$ = 174). Several risk factors were found to be associated with lower back pain, including working overtime (AOR = 1.13, $p < 0.01$; 95% CI: 0.07–0.22), performing repetitive tasks (AOR = 8.06, $p < 0.01$; 95% CI: 4.67–13.93), bending (AOR = 7.77, $p < 0.01$; 95% CI: 3.97–15.22), and twisting (AOR = 3.32, $p < 0.01$; 95% CI: 1.83–6.03). Based on these findings, it is recommended that an ergonomic risk assessment and prevention program be implemented, which should include educational awareness about lower back pain and its prevention among mine workers.

**Keywords:** occupational risks; ergonomic risks; work-related risk factor; mining; lower back pain; nickel

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## 1. Introduction

Lower back pain (LBP) is one of the difficult conditions that are frequently related to mining, both above and below the ground [1]. The mining industry is characterized by dynamic work processes, constantly changing, and posing threats to workers' health and safety [2]. With an emphasis on the interaction between workers and the work environment, ergonomics is referred to as the application of psychological and physiological concepts to the design of goods, processes, and systems, attempts to improve safety and comfort [3]. In the mining sector, musculoskeletal disorders (MSDs) have long been recognized as a serious and expensive condition [4]. One of the frequent MSDs that affects almost everyone at some point in their lives is LBP, which is brought on by injury to a muscle (strain) or ligament (sprain). According to Alsubaie et al. (2023), LBP is one of the most prevalent musculoskeletal illnesses worldwide and a significant occupational hazard [5].

Scientific evidence suggests that lower back pain reoccurrence is very common in men who work in mines [6–8]. Again, lower back pain can be exacerbated by smoking, obesity, weight gain during pregnancy, stress, poor physical condition, poor posture, and poor sleeping conditions [9]. It is estimated that 60% to 80% of adults in Western countries are likely to develop LBP [10], and 80% of the population will experience at least one episode of LBP in their lifetime [11]. According to Ilic and colleagues in 2021, LBP was classified as one of the top ten conditions that contribute to sickness and injuries [11]. Additionally, it accounts for 40% of workplace absences [12]. Himalowa and Frantz (2010) indicated a 25% prevalence of LBP among South African construction workers, with prevalence rates of 69% after one month and 54% after one week [13]. In Nigeria, over 70% of nursing professionals suffer LBP as a result of poor ergonomic practices and workplace health and safety dangers [14]. Andrusaitis, Oliveira, Eloy, and Barros Filho (2006) assert that LBP has an impact on a variety of workforces, including truckers like truck drivers, with a 59% frequency of LBP in Brazilian drivers [15]. In Africa, the mean point prevalence of LBP in adults is 32%, and the lifetime prevalence rate is 62% [16]. Research was carried out in African countries for the prevalence of lower back pain, and it was inclusive of Zimbabwe. According to this study, Zimbabwe had a 40% incidence of LBP among the 23–76 years of age in a period of one year [17]. Also, the lifetime low back prevalence was 58% between the ages of 23 and 76 years [17]. There is a gap in the inclusion of industrial employees who are engaged in heavy work with harsh working conditions, such as mining. In Zimbabwe, most ergonomic studies focused on the nursing profession, school children, and physiotherapists, with a dearth of literature on ergonomic conditions in the mining sectors.

Mineworkers are facing a significant potential risk of injuries due to the nature of their job, often characterized by its physical demand [18]. The repeated and ongoing work activities such as drilling, lifting, bending backs, prolonged standing, and long working hours are major predictors of lower back pain [18]. Irrespective of improved technology in the mining industry, equipment that is now being used in daily activities of the mining sector, such as haul trucks and belt conveyors, has also contributed to LBP [19,20] due to the aforementioned activities. Many work tasks, including equipment used, have been suggested to cause mechanical vibrating pressure that exerts unusual biomechanical stress on the whole body, resulting in LBP [21]. A lower back disability associated with strenuous work activities has been associated with occupational absenteeism, socioeconomic consequences, and high healthcare utilization [22]. The increase in job withdrawal and absentees due to LBP among nickel miners motivated this study. Our study aimed to determine the ergonomic risk factors associated with lower back pain among mineworkers in a nickel mine in Zimbabwe.

## 2. Materials and Methods

### 2.1. Study Design and Setting

An analytical cross-sectional study was conducted to achieve the two objectives (the study objective (prevalence of lower back pain and associated workplace and ergonomic risk factors). The study was conducted between September and November 2022 in an underground nickel mine in Zimbabwe. The mine is situated in the northeastern of Harare (the capital city of Zimbabwe), about 88–90 km away in the Mazowe Valley [23]. It is near Bindura District in the Mashonaland Central Province.

### 2.2. Study Population and Sampling

The study was conducted among 420 mineworkers; the study included male and female workers working in an underground mine. A simple random sampling was used, every second mine worker was selected until the design sample size was achieved. The sample size was determined using the Centers for Disease Control and Prevention (CDC), EpInfo version 7.2.2.6 for cross-sectional studies. Using Equation (1), the estimated population size was 393 (N), while the hypothesized prevalence (p) was 64.9% from a previous study [8], the precision (d) was 5%, Z = 1.96, and the design effect (DEFF) was set at 1. Therefore, the estimated sample size was 187.

$$n = [\text{DEFF} \times \text{Np}(1 - \text{p})]/[(\text{d2}/\text{Z21} - \alpha/2 \times (\text{N} - 1) + \text{p} \times (1 - \text{p})]. \quad (1)$$

### *2.3. Data Collection*

The face-to-face interviewer-administered questionnaire was used to collect data on the lower back pain prevalence, socio-demographic, behavioral factors, and ergonomic and occupational (work-related) risk factors. The questionnaire consisted of three sections: (A) socio-demographics and behavioral information, (B) prevalence of lower back pain, and (C) ergonomic and occupational factors discussed in detail below. The principal investigator (KPZ) and trained research assistants administered the questionnaire in English. Prior to the actual study, the questionnaire was piloted among 10 employees from the same study site who were excluded from the final sample.

#### 2.3.1. Lower Back Pain

To determine the prevalence of lower back pain in the study. The miners were asked if they "have or had pain or discomfort in the past 12 months. The response was categorized into "yes" (miners with lower back pain) and "no" (miners without lower back pain subjects).

#### 2.3.2. Socio-Demographic and Behavioral Factors

The questionnaire was used to collect the following socio-demographics: age (30 years or younger, 31–40 years old, 41–50 years old, and 51 years or older), gender (male/female), education level, marital status (single, married, and widower/divorced), and occupation (general workers, supervisor, artisans/technicians), which included the following machine operator: fixed operator, mobile/plant operator, boiler making blasting, construction, drilling, electrician, fitter, spillage, and trimming) and miners. The participants were also asked if they were left-handed or not. Furthermore, the participants were asked about personal behavioral traits such as smoking (yes/no), drinking alcohol (yes/no), and healthy living (yes/no), for example, exercising, running, playing sports, etc.

#### 2.3.3. Ergonomic and Occupational Factors

The selected questions from the Dutch Musculoskeletal Questionnaire (DMQ) were used to assess the occupational and ergonomic risk factors in this study [24]. The questions adapted from the DMQ questionnaire are described in Table 1 below.

**Table 1.** Questions on occupational and ergonomic risk factors.

| Factors | Question | Variable Name and Response |
|---|---|---|
| Occupational risk factors | How long have you worked in the same environment? | Work experience (less than 5 years/6–15 years/16–25 years/25 years or more) |
| | Are you a part-time or casual employee? | Part-time work (no/yes) |
| | How many days do you work per week? | Working days a week (less than 7 days/7 or more days) |
| | How many hours per day do you work? | Hours per day (8 h or less/more than 8 h) |
| | Do you believe that there is a shortage of staff in your unit/department/team? | Shortage of staff (no/yes) |
| | Do you believe that your work physical labor | Physical labor (no/yes) |
| | Does the work/task you do rotate between you and your team members? | Rotation (no/yes) |
| | Are you required to work overtime? | Overtime (no/yes) |
| | Do you believe you get enough time to rest either in a day or in a month? | Resting time (no/yes) |

**Table 1.** *Cont.*

| Factors | Question | Variable Name and Response |
|---|---|---|
| Ergonomic risk factors | Does your work involve doing repetitiveness tasks many times per minute | Standing (no/yes) |
| | Does your work involve standing for extended periods? | Standing (no/yes) |
| | Does your work involve completing tasks in a bent position for an extended period? | Bending (no/yes) |
| | Does your work involve twisting/holding your trunk twisted for extended periods? | Twisting (no/yes) |
| | Does your work involve carrying heavy objects daily? | Carrying heavy objects (no/yes) |
| | Does your work involve lifting and placing objects from one place to another? | Lifting (no/yes) |
| | Does your work involve working in the same position for long periods | Static (no/yes) |
| | Does your work involve working with your hands above shoulder level | Shoulder (no/yes) |
| | Do you work with vibration tools for long periods | Vibration (no/yes) |
| | Do you complete your daily activities in a hot environment? | Heat (no/yes) |
| | Do you complete your tasks in a cold environment? | Cold (no/yes) |
| | Do you frequently encounter the issue of your work clothes becoming wet after completing a shift? | Wet clothes (no/yes) |

### *2.4. Data Analysis*

The data were analyzed using IBM SPSS software version 29.0.0.0 (IBM Inc., Chicago, IL, USA). Descriptive statistics were utilized to tabulate lower back pain, demographics, and risk factors using frequencies and percentages. Pearson correlation was employed to ascertain the relationship between socio-demographic factors and symptoms related to lower back pain. Fischer’s test was utilized to determine any statistical differences among risk factors when comparing individuals with lower back pain to those without. The risk factors associated with lower back pain were determined through a multivariate logistic regression model. Initially, all the risk factors were individually fitted to the binary logistic regression model and reported as the crude odds ratio (COR) along with a 95% confidence interval (95% CI). Those risk factors that were statistically significant with a $p$-value of 0.050 or less were then included in the final model. In the final multivariate logistic regression model, a $p$-value of 0.050 was set to determine statistical significance.

## 3. Results

### *3.1. Prevalence of Lower Back Pain and Related Symptoms*

The participants were evaluated regarding their experiences with symptoms related to lower back pain, shown in Figure 1. A greater number of participants reported experiencing stiffness ($n$ = 202, 10%), spasms ($n$ = 198, 47.14%), and poor posture ($n$ = 223, 53.10%), specifically in the lower back region. Participants who reported experiencing all three symptoms were classified as having experienced lower back pain. In total, 41.43% ($n$ = 174) of participants in the study reported having experienced lower back pain, and 246 (58.57%) had not experienced lower back pain.

### *3.2. Study Participants Socio-Demographics*

Four hundred and twenty mine workers participated in the study. The majority of participants in the study were 31–40 years old ($n$ = 159, 37.9%), and it was observed that this particular age group had a high prevalence of lower back pain ($n$ = 58, 33.33%). In terms of gender, there were more males ($n$ = 259, 61.7%) than females ($n$ = 161, 38.3%), and there were more males who had experience. The participants’ occupations were divided into four categories: miners ($n$ = 206, 49.05%), general workers ($n$ = 184, 43.81%), and supervisors ($n$ = 30, 7.14%). The lower back pain prevalence was high among miners ($n$ = 117, 46.80%). Among these categories, miners had the highest number of participants. In the total population, only 10.24% ($n$ = 43) of the population were left-handed in the study. More than half of the population indicated that they neither smoke ($n$ = 334, 79.52%) nor drink alcohol ($n$ = 248, 59.05%), and the prevalence of lower back pain was higher among non-smokers ($n$ = 135, 77.59%). Lastly, the majority of the participants lived a healthy life ($n = 262$, 62.4%) and had not experienced a serious injury outside the workplace ($n = 365$, 86.90%).

When comparing the two groups (those without lower back pain vs. those with lower back pain), the following variables exhibited statistically significant differences: educational level ($p = 0.01$), occupation ($p = 0.03$), and healthy lifestyle ($p < 0.01$). The description and comparison are presented in Table 2 below.

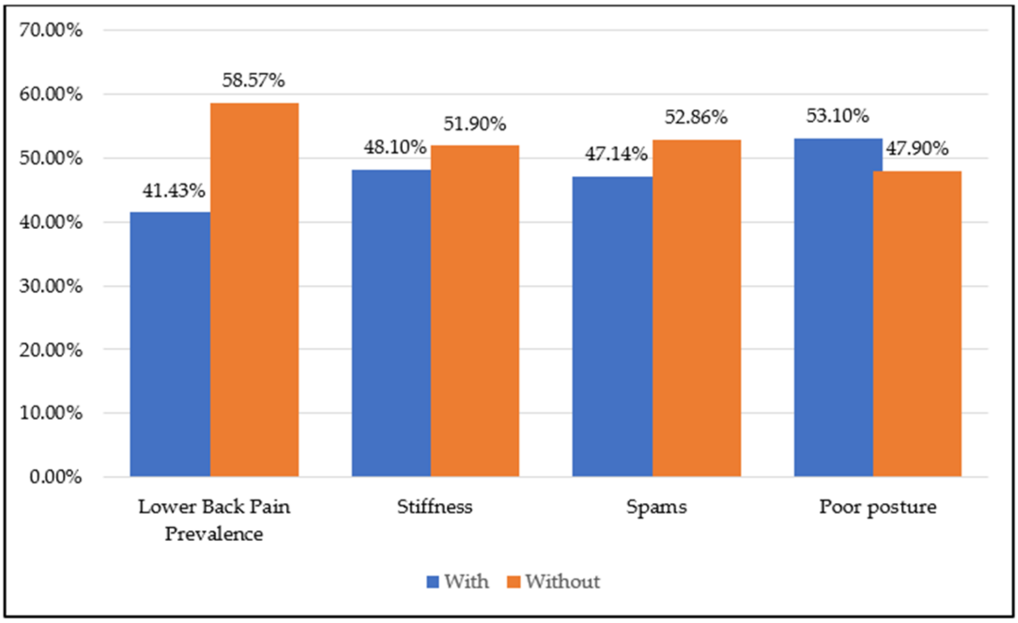


**Figure 1.** The prevalence of lower back pain and related symptoms.

**Table 2.** Description of socio-demographics according to the prevalence of lower back pain.

| Socio-Demographic | | Total *n* (%) | Without Lower Back Pain | With Lower Back Pain | *p*-Value [a] |
|---|---|---|---|---|---|
| Age | 30 years or younger | 85 (20.2%) | 46 (18.70%) | 39 (22.41%) | 0.21 |
| | 31–40 years old | 159 (37.9%) | 101 (41.06%) | 58 (33.33%) | |
| | 41–50 years old | 128 (30.48%) | 76 (30.89%) | 52 (29.89%) | |
| | 51 years or older | 48 (11.4%) | 23 (9.35%) | 25 (14.37%) | |
| Gender | Female | 161 (38.3%) | 101 (41.06%) | 60 (34.48%) | 0.19 |
| | Male | 259 (61.7%) | 145 (58.94%) | 114 (65.52%) | |
| Education level | No schooling | 321 (76.4%) | 187 (76.02%) | 134 (77.01%) | 0.01 * |
| | Primary schooling-Matric | 88 (21%) | 48 (19.51%) | 40 (22.09%) | |
| | Tertiary | 11 (2.6%) | 11 (4.47%) | 0 | |
| Occupation | General | 117 (19.76%) | 20 (11.76%) | 97 (38.80%) | 0.03 * |
| | Artisans or technicians | 101 (24.05%) | 36 (18.24%) | 36 (14.40%) | |
| | Supervisor | 30 (7.14%) | 30 (17.65%) | 0 | |
| | Miner | 206 (49.05%) | 89 (52.35%) | 117 (46.80%) | |
| Left-handed | No | 377 (89.8%) | 225 (91.46%) | 152 (87.36%) | 0.19 |
| | Yes | 43 (10.24%) | 21 (8.54%) | 22 (12.46%) | |
| Smoking | No | 334 (79.52%) | 199 (80.89%) | 135 (77.59%) | 0.46 |
| | Yes | 86 (20.84%) | 47 (19.11%) | 39 (22.41%) | |
| Drinking alcohol | No | 248 (59.05%) | 119 (53.60%) | 129 (65.15%) | 0.55 |
| | Yes | 172 (40.95%) | 103 (46.40%) | 69 (34.85%) | |
| Healthy living | No | 158 (37.6%) | 0 | 158 (90.80%) | <0.01 * |
| | Yes | 262 (62.4%) | 246 (100%) | 16 (9.20%) | |
| Injury outside workplace | No | 365 (86.9%) | 220 (89.43%) | 145 (83.33%) | 0.08 |
| | Yes | 55 (13.10%) | 26 (10.57%) | 29 (16.67%) | |

[a]—*p*-value = Fischer's test. * Statistically significant at 0.05.

### 3.3. The Relationship between Socio-Demographics and Lower Back Pain-Related Symptoms

The study assessed the relationship between participants' socio-demographics and lower back pain-related symptoms. Healthy living had a negatively significant correlation with stiffness (r = −0.21, $p \leq 0.01$), posture (r = −0.18, $p = 0.01$), and spasms (r = −0.44, $p \leq 0.03$). Furthermore, smoking had a significant positive relationship with stiffness (r = 0.14, $p < 0.01$). Please refer to Table 3 for a comprehensive description of the correlation relationships between socio-demographic variables and lower back pain. The table also depicts the relationships among socio-demographic variables.

**Table 3.** Correlation relationships between selected socio-demographics and lower back pain-related symptoms.

| Variables | Age | Gender | Educational Level | Occupation | Left-Handed | Smoking | Drinking Alcohol | Healthy Living | Injury Outside | Stiffness | Posture | Spasms |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1 | | | | | | | | | | | |
| Gender | 0.19 [a] (<0.01) * | 1 | | | | | | | | | | |
| Educational Level | −0.01 (0.88) | 0.13 (0.01) | 1 | | | | | | | | | |
| Occupation | −0.08 (0.09) | −0.01 (0.95) | 0.06 (0.25) | 1 | | | | | | | | |
| Left-handed | −0.04 (0.36) | 0.01 (0.87) | −0.18 (<0.01) * | 0.56 (0.66) | 1 | | | | | | | |
| Smoking | 0.04 (0.39) | 0.09 (0.08) | −0.17 (<0.01) * | 0.76 (0.09) | 0.01 (0.89) | 1 | | | | | | |
| Drinking alcohol | 0.57 (0.31) | 0.10 (0.09) | 0.29 (0.07) | 0.02 (0.98) | 0.87 (0.09) | 0.75 (0.58) | 1 | | | | | |
| Healthy living | −0.14 (0.77) | −0.07 (0.18) | 0.08 (0.09) | −0.40 (<0.01) * | −0.09 (0.05) * | −0.08 (0.10) | −0.10 (0.60) | 1 | | | | |
| Injury outside | 0.30 (<0.01) * | 0.05 (0.36) | 0.05 (0.30) | 0.03 (0.54) | 0.08 (0.11) | 0.24 (<0.01) * | 0.09 (0.14) | −0.09 (0.06) | 1 | | | |
| Stiffness | 0.18 (0.13) | −0.09 (0.06) | 0.08 (0.09) | 0.05 (0.27) | 0.09 (0.07) | 0.14 (<0.01) * | 0.25 (0.17) | −0.21 (<0.01) * | 0.10 (0.03) * | 1 | | |
| Posture | 0.08 (0.14) | −0.18 (0.08) | 0.13 (0.25) | 0.33 (0.32) | 0.07 (0.22) | 0.45 (0.09) | 0.41 (0.66) | −0.18 (0.01) * | 0.23 (0.05) * | 0.45 (0.04) * | 1 | |
| Spasms | 0.27 (0.25) | −0.24 (0.22) | 0.77 (0.31) | 0.98 (0.40) | 0.01 (0.09) | 0.50 (0.38) | 0.03 (0.10) | −0.44 (0.03) | 0.29 (0.09) | −0.21 (<0.01) * | −0.11 (0.01) * | 1 |

[a]—Pearson correlation. * Statistically significant at 0.05.

### 3.4. Occupational-Related and Ergonomic Risk

The majority of the study participants (38.33% (61) of the $n = 420$) had work experience ranging from 6 to 15 years. However, those with work experience of 16 to 25 years exhibited a high prevalence of lower back pain ($n = 61$, 35.09%). Less than half of the participants indicated that they were employed part-time ($n = 89$, 21.19%), and 12 (6.90%) had experienced lower back pain. More participants worked 7 or more days per week, 295 (70.24%), and most worked 8 h or less a day, 214 (50.95%). Two hundred and nineteen participants did not believe there was a shortage of staff (52.14%), and 247 (58.81%) believed their worker was demanding (out of the 247, 65.52% ($n = 114$) had experienced lower back pain). Out of the 172 (40.95%) who worked overtime, 36 (20.69%) had lower back pain. When comparing the two groups (no lower back pain vs. lower back pain), the following variables showed a statistical difference: work experience ($p = 0.03$), part-time work ($p < 0.01$), number of working days a week ($p = 0.02$), number of hours worked per day ($p < 0.01$), shortage of staff ($p < 0.01$), physical labor ($p = 0.02$), and working overtime ($p < 0.01$). The comparison of the occupational-related risk occupational factors is shown in Table 4.

**Table 4.** Comparison of the occupation-related risk factors.

| Occupational Related Risk | | Total n (%) | Without Lower Back Pain | With Lower Back Pain | p-Value [a] |
|---|---|---|---|---|---|
| Work experience | Less than 5 years | 89 (21.19%) | 56 (22.76%) | 33 (18.97%) | 0.03 * |
| | 6–15 years | 161 (38.33%) | 105 (42.68%) | 56 (32.18%) | |
| | 16–25 years | 109 (25.95%) | 48 (19.52%) | 61 (35.06%) | |
| | 25 years or more | 61 (14.52%) | 37 (15.04%) | 24 (13.79%) | |
| Part-time work | No | 331 (78.81%) | 169 (68.70%) | 162 (93.10%) | <0.01 * |
| | Yes | 89 (21.19%) | 77 (31.30%) | 12 (6.90%) | |
| Working days a week | Less than 7 days | 125 (29.76%) | 84 (34.15%) | 41 (23.56%) | 0.02 * |
| | 7 or more days | 295 (7024%) | 162 (65.85%) | 133 (76.44%) | |
| Hours per day | 8 h or less | 214 (50.95%) | 173 (70.33%) | 41 (23.56%) | <0.01 * |
| | More than 8 h | 206 (49.05%) | 73 (29.67%) | 133 (76.44%) | |
| Shortage of staff | No | 219 (52.14%) | 88 (35.77%) | 131 (75.29%) | <0.01 * |
| | Yes | 201 (47.86%) | 158 (64.23%) | 43 (24.71%) | |
| Physical labor | No | 173 (41.19%) | 113 (45.93%) | 60 (34.48%) | 0.02 * |
| | Yes | 247 (58.81%) | 133 (54.07%) | 114 (65.52%) | |
| Rotation | No | 248 (59.05%) | 146 (59.35%) | 102 (58.62%) | 0.92 |
| | Yes | 172 (40.95%) | 100 (40.65%) | 72 (41.38%) | |
| Overtime | No | 248 (59.05%) | 110(44.72%) | 138 (79.31%) | <0.01 * |
| | Yes | 172 (40.95%) | 136 (55.28%) | 36 (20.69%) | |
| Resting time | No | 205 (48.81%) | 123 (50%) | 82 (47.13%) | 0.62 |
| | Yes | 215 (51.19%) | 123 (50%) | 92 (52.87%) | |

[a]—p-value = Fischer's test. * Statistically significant at 0.05.

There were a greater number of participants who were not involved in the following daily repetitive tasks ($n$ = 331, 78.81%): static work ($n$ = 242, 57.62%), working in hot environments ($n$ = 279, 66.43%), working in cold places ($n$ = 273, 65%), and experiencing sweating leading to wet clothes ($n$ = 273, 65%). Additionally, a higher number of participants reported experiencing lower back pain during the following tasks conducted for extended periods: standing ($n$ = 169, 97.13%; $p < 0.01$), bending ($n$ = 155, 89.08%; $p < 0.01$), twisting ($n$ = 134, 77.01%; $p = 0.02$), carrying heavy objects ($n$ = 146, 83.91%; $p = 0.02$), lifting objects ($n$ = 151, 86.78%; $p < 0.01$), and carrying objects above shoulder height ($n$ = 173, 99.43%; $p < 0.01$). The full description of comparing the ergonomics risk factors according to outcome variables is shown in Table 5.

**Table 5.** Comparison of the ergonomic risk factors.

| Ergonomic Risk | | Total n (%) | Without Lower Back Pain | With Lower Back Pain | p-Value [a] |
|---|---|---|---|---|---|
| Repetitiveness | No | 331 (78.81%) | 178 (72.36%) | 44 (25.29%) | <0.01 * |
| | Yes | 89 (21.19%) | 77 (31.30%) | 12 (6.90%) | |
| Standing | No | 251 (59.79%) | 246 (100%) | 5 (2.87%) | <0.01 * |
| | Yes | 169 (40.24%) | 0 | 169 (97.13%) | |
| Bending | No | 116 (27.62%) | 97 (39.43%) | 19 (10.92%) | <0.01 * |
| | Yes | 304 (72.38%) | 149 (60.57%) | 155 (89.08%) | |
| Twisting | No | 112 (29.05%) | 82 (33.33%) | 40 (22.99%) | 0.02 * |
| | Yes | 298 (70.95%) | 164 (66.67%) | 134 (77.01%) | |
| Carrying heavy objects | No | 175 (41.67%) | 147 (59.76%) | 28 (16.09%) | 0.02 * |
| | Yes | 245 (58.33%) | 99 (40.24%) | 146 (83.91%) | |
| Lifting | No | 269 (64.05%) | 246 (100%) | 0 | <0.01 * |
| | Yes | 151 (35.95%) | 0 | 151 (86.78%) | |
| Static | No | 242 (57.62%) | 146 (59.35%) | 96 (55.17%) | 0.42 |
| | Yes | 178 (42.38%) | 100 (40.65%) | 78 (44.83%) | |

**Table 5.** *Cont.*

| Ergonomic Risk | | Total n (%) | Without Lower Back Pain | With Lower Back Pain | p-Value [a] |
|---|---|---|---|---|---|
| Shoulder | No<br>Yes | 247 (58.81%)<br>173 (41.19%) | 246 (100%)<br>0 | 1 (0.57%)<br>173 (99.43%) | <0.01 * |
| Vibration | No<br>Yes | 205 (48.81%)<br>215 (51.19%) | 127 (51.63%)<br>119 (48.37%) | 78 (44.83%)<br>96 (55.17%) | 0.20 |
| Heat | No<br>Yes | 279 (66.43%)<br>141 (33.57%) | 170 (69.11%)<br>76 (30.86%) | 109 (62.64%)<br>65 (37.36%) | 0.174 |
| Cold | No<br>Yes | 273 (65%)<br>147 (35%) | 168 (68.29%)<br>78 (31.71%) | 105 (60.34%)<br>69 (39.66) | 0.20 |
| Wet clothes | No<br>Yes | 248 (59.05%)<br>172 (40.95%) | 149 (60.57%)<br>97 (39.43%) | 99 (56.90%)<br>74 (43.10%) | 0.48 |

[a]—*p*-value = Fischer's test. * Statistically significant at 0.05.

### 3.5. Risk Factors Associated with Lower Back Pain in the Study

Table 6 below only shows the study multivariate analysis results of risk factors associated with lower back pain. The bivariate analysis was conducted to identify single-factor statistically significant occupational and ergonomic risk factors associated with lower back pain. The results of the bivariate analysis are presented in Appendix A, Tables A1 and A2, demonstrating an association (either present or absent in both the bivariate and multivariate analyses) between lower back pain and occupational and ergonomic risk factors, respectively. Additionally, Table 4 displays the significant associations observed between lower back pain and risk factors (both occupational-related and ergonomic) in both the bivariate and multivariate analyses. The study identified working overtime (AOR = 1.13, $p < 0.01$; 95% CI: 0.07–0.22), doing repetitiveness tasks (AOR = 8.06, $p < 0.01$; 95%CI: 4.67–13.93), and bending (AOR = 7.77, $p < 0.01$; 95% CI: 3.97–15.22) and twisting (AOR = 3.32, $p < 0.01$; 95% CI: 1.83–6.03) for extended periods while completing tasks.

**Table 6.** Occupational-related and ergonomic risk factors associated with lower back pain in the study.

| Risk Factor | | COR | p-Value | 95% CI | AOR | p-Value | 95% CI |
|---|---|---|---|---|---|---|---|
| Overtime | No | | | | **Ref** | | |
| | Yes | 1.21 | <0.01 * | 0.14–0.33 | 1.13 | <0.01 * | 0.07–0.22 |
| Repetitiveness | No | | | | **Ref** | | |
| | Yes | 7.74 | <0.01 * | 4.80–12.49 | 8.06 | <0.01 * | 4.67–13.93 |
| Bending | No | | | | **Ref** | | |
| | Yes | 5.31 | <0.01 * | 3.09–9.12 | 7.77 | <0.01 * | 3.97–15.22 |
| Twisting | No | | | | **Ref** | | |
| | Yes | 1.67 | 0.02 * | 1.08–2.60 | 3.32 | <0.01 * | 1.83–6.03 |

* *p*-value statistically significant at 0.054.

## 4. Discussion

The findings of our study provide significant insights into the prevalence and sociodemographic factors associated with LBP among nickel mineworkers in Zimbabwe. Notably, 41.43% of the participants reported experiencing LBP, characterized by stiffness, spasms, and poor posture. This prevalence aligns with existing literature, which consistently identifies LBP as a common musculoskeletal complaint across various populations [25]. The prevalence of specific symptoms reported in this study—stiffness (10%), spasms (47.14%), and poor posture (53.10%)—highlights the multifaceted nature of LBP. These findings are consistent with previous studies that have reported similar symptom profiles among individuals with LBP. For instance, a survey by Balagué et al. (2012) found that muscle stiffness and spasms are common manifestations of LBP, often resulting from muscle strain or ligament sprain [26]. Additionally, poor posture has been widely recognized as both a contributing factor and a consequence of LBP, underscoring the importance of ergonomic and postural interventions in managing this condition [27]. The negative correlations between healthy living and the symptoms of stiffness (r = −0.21, $p < 0.01$), posture (r = −0.18, $p = 0.01$), and spasms (r = −0.44, $p < 0.03$) suggest that lifestyle factors play a crucial role in the development and management of LBP. These findings corroborate the results of other studies that have demonstrated the beneficial impact of a healthy lifestyle on musculoskeletal health. Shiri et al. (2010) found that regular physical activity, maintaining a healthy weight, and avoiding smoking were associated with reduced risk and severity of LBP [3]. The significant negative correlation between healthy living and muscle spasms in particular (r = −0.44, $p < 0.03$) emphasizes the potential of lifestyle modifications in alleviating this specific symptom, which is often a source of considerable discomfort and disability.

In this study, less than half of the participants were employed part-time, with 21.19% ($n$ = 89) indicating part-time employment. Among these, only 6.90% ($n$ = 12) reported experiencing LBP. These results suggest that part-time employment may not significantly contribute to LBP in this cohort. Similar findings were observed in a study conducted by Chowdhury et al. [28], which found that part-time workers experienced fewer musculoskeletal complaints, including LBP, compared to full-time workers. The reduced physical demand and shorter working hours typical of part-time roles may explain this lower prevalence, as these conditions may offer more opportunities for rest and recovery, reducing the risk of LBP. A significant portion of the participants (70.24%, $n$ = 295) worked seven or more days per week, and over half (50.95%, $n$ = 214) worked eight hours or less per day. The extended working periods indicated in these findings are concerning, as they are likely to contribute to physical strain, potentially leading to LBP. Prolonged working hours have been associated with musculoskeletal issues, including LBP, in various studies. For instance, a study by da Costa et al [29] demonstrated that workers with extended work hours were more prone to developing LBP due to cumulative physical stress and inadequate recovery time. However, in the present study, only those working overtime showed a significant association with LBP, with 20.69% ($n$ = 36) of those working overtime experiencing LBP. This suggests that additional working hours beyond the standard day may significantly increase the risk of LBP, corroborating findings by Bontrup et al. (2019), who reported a higher incidence of LBP among workers with frequent overtime hours [1].

Interestingly, 52.14% ($n$ = 219) of the participants did not perceive a shortage of staff, despite the majority 58.81% ($n$ = 247) considering their work demanding. Of the latter group, 65.52% ($n$ = 114) experienced LBP. This finding is crucial as it indicates that even without perceiving staff shortages, the physical demands of work alone may predispose workers to LBP. This observation is consistent with a study by Yang et al. (2016), which found that high physical job demands were a significant predictor of LBP, independent of other workplace factors like staffing levels [30]. The high prevalence of LBP among those who perceived their work as demanding underscores the critical role of job demands in the development of LBP, suggesting that managing workload effectively is key to preventing musculoskeletal disorders in the workplace. Several variables showed statistically significant differences between participants with and without LBP, including part-time work ($p < 0.01$), the number of working days per week ($p = 0.02$), the number of hours worked per day ($p < 0.01$), perceptions of staff shortages ($p < 0.01$), physical labor ($p = 0.02$), and working overtime ($p < 0.01$). These findings indicate that these factors are significant contributors to the development of LBP.

The significant association between part-time work and LBP ($p < 0.01$) may suggest that part-time workers might engage in other physically demanding activities outside their primary employment, increasing their risk for LBP. This finding is somewhat contrary to studies like that by Yang et al. (2016), which reported lower rates of LBP among part-time workers [30]. This discrepancy could be due to differences in the nature of part-time work across different settings or regions. The number of working days and hours worked per day being significantly associated with LBP ($p = 0.02$ and $p < 0.01$, respectively) supports the idea that prolonged exposure to physical labor without adequate rest increases the risk of LBP. This finding aligns with research by Inoue et al. (2019), which found that longer working hours were directly correlated with an increased incidence of LBP, emphasizing the need for balanced work schedules to prevent musculoskeletal issues [31]. The significant association between the perception of staff shortages and LBP ($p < 0.01$) highlights that in environments where workers perceive staffing to be adequate, physical and psychological burdens might still exist due to the nature of the job itself. Physical labor ($p = 0.02$) and overtime work ($p < 0.01$) are confirmed risk factors for LBP, consistent with the findings of a study by Sowah et al. (2018), which also noted that physical exertion and extended work hours significantly increase the risk of developing LBP [32].

A significant number of participants (78.81%, $n = 331$) were not involved in daily repetitive tasks such as static work (57.62%, $n = 242$), working in hot environments (66.43%, $n = 279$), working in cold places (65%, $n = 273$), and experiencing sweating that led to wet clothes (65%, $n = 273$). The lower engagement in these tasks suggests a reduced risk of LBP associated with repetitive strain, which is consistent with the findings of Dong et al. (2022), who observed that workers involved in repetitive static postures or extreme temperature environments were more likely to report musculoskeletal discomfort, including LBP [33]. The absence of these stressors in the majority of participants might explain the relatively lower incidence of LBP in this subgroup. The study highlights that a significant number of participants reported experiencing LBP during tasks that involve prolonged physical exertion, particularly standing (97.13%, $n = 169$), bending (89.08%, $n = 155$), twisting (77.01%, $n = 134$), carrying heavy objects (83.91%, $n = 146$), lifting objects (86.78%, $n = 151$), and carrying objects above shoulder height (99.43%, $n = 173$). These findings underscore the strong association between these physically demanding tasks and the prevalence of LBP, with statistically significant results for standing ($p < 0.01$), bending ($p < 0.01$), twisting ($p = 0.02$), carrying heavy objects ($p = 0.02$), lifting objects ($p < 0.01$), and carrying objects above shoulder height ($p < 0.01$).

These results align with existing literature, such as the study by Shiri et al. (2018), which reported that workers performing tasks involving awkward postures, heavy lifting, and prolonged standing were at a higher risk of developing LBP [3]. The mechanical load placed on the lumbar spine during these activities is well documented as a contributing factor to LBP, as confirmed by Bauerle et al. (2022), who found a direct correlation between the intensity of physical tasks and the severity of LBP among workers [2].

The high incidence of LBP reported during standing, bending, and lifting tasks in this study is comparable to findings from similar occupational health research. For example, a study by Nieminen et al. (2021) found that workers in physically demanding jobs, who frequently engage in heavy lifting and prolonged standing, were significantly more likely to report LBP [33]. This is consistent with the present study, where nearly all participants who carried objects above shoulder height (99.43%) reported LBP, indicating that tasks requiring extended reach or overhead activities place considerable strain on the lower back. Furthermore, the association of LBP with twisting (77.01%, $p = 0.02$) and carrying heavy objects (83.91%, $p = 0.02$) is supported by research from the European Working Conditions Survey (EWCS), which found that workers engaged in frequent twisting or carrying heavy loads were at an increased risk for LBP [34]. This suggests that interventions targeting these specific tasks could be effective in reducing the burden of LBP among workers.

The relationship between socio-demographic factors and LBP-related symptoms observed in this study adds to the growing body of evidence on the social determinants of health in musculoskeletal disorders [35,36]. Socio-demographic variables such as age, gender, occupation, and socioeconomic status have been shown to influence the prevalence and severity of LBP [37]. For example, a study by Strine and Hootman (2007) found that LBP was more prevalent among individuals with lower socioeconomic status and those engaged in physically demanding occupations [38]. The negative correlation between healthy living and LBP-related symptoms in our study suggests that interventions aimed at promoting healthy behaviors could be particularly beneficial in populations at higher risk of LBP due to socio-demographic factors [38].

Less than half of the participants indicated part-time employment ($n$ = 89, 21.19%), with a smaller fraction of these reporting LBP ($n$ = 12, 6.90%). A larger proportion of participants ($n$ = 295, 70.24%) worked seven or more days per week, and most ($n$ = 214, 50.95%) worked eight hours or less per day. A notable observation was that 219 participants (52.14%) did not perceive a staff shortage, while 247 (58.81%) found their work demanding, with 65.52% ($n$ = 114) of these experiencing LBP. Additionally, among the 172 participants (40.95%) who reported working overtime, 36 (20.69%) experienced LBP. These findings are consistent with existing literature that identifies long working hours, overtime, and physically demanding work as key risk factors for LBP [39]. The statistically significant differences observed between participants with and without LBP regarding part-time work ($p < 0.001$), number of working days per week ($p = 0.023$), number of hours worked per day ($p < 0.001$), perceived staff shortage ($p < 0.001$), physical labor ($p = 0.021$), and working overtime ($p < 0.001$) underscore the multifaceted nature of LBP in occupational settings.

The significant association between LBP and the perception of a demanding job aligns with previous studies. Hoogendoorn et al. (2000) found that high job demands and physical workload were strongly associated with the incidence of LBP [40]. This suggests that the physical and psychological stress experienced by workers in demanding jobs may contribute to musculoskeletal strain and pain. The perceived shortage of staff, leading to increased workload and pressure on remaining employees, exacerbates the risk of LBP, a finding supported by Harkness and colleagues in 2003 [41]. The high prevalence of LBP among participants who work overtime is particularly noteworthy. Extended work hours have been shown to correlate with musculoskeletal disorders [42]. The physiological stress associated with prolonged working hours, combined with inadequate rest and recovery time, likely contributes to the development of LBP. This suggests the importance of regulating work hours and ensuring adequate rest periods to mitigate the risk of LBP among workers. The finding that only 21.19% of part-time workers experienced LBP suggests that job structure and scheduling play critical roles in the development of LBP. Part-time workers may have more flexibility and less cumulative physical strain, which could account for the lower prevalence of LBP in this group. This observation aligns with the findings of a study by Sadeghian et al. (2014), which reported lower rates of LBP among workers with flexible working hours compared to those with rigid schedules [43].

Our study also revealed significant ergonomic risk factors associated with LBP among the participants. A majority were not engaged in daily repetitive tasks ($n$ = 331, 78.81%), static work ($n$ = 242, 57.62%), working in hot environments ($n$ = 279, 66.43%), working in cold places ($n$ = 273, 65%), or experiencing sweating leading to wet clothes ($n$ = 273, 65%). This suggests that while these conditions are present in some workplaces, they may not be the primary contributors to LBP in this cohort. However, the data indicate that LBP was notably prevalent among participants performing specific tasks for extended periods. A high number of participants reported experiencing LBP during activities such as standing ($n$ = 169, 97.13%; $p < 0.001$), bending ($n$ = 155, 89.08%; $p < 0.001$), twisting ($n$ = 134, 77.01%; $p = 0.022$), carrying heavy objects ($n$ = 146, 83.91%; $p = 0.021$), lifting objects ($n$ = 151, 86.78%; $p < 0.001$), and carrying objects above shoulder height ($n$ = 173, 99.43%; $p < 0.001$). These activities are well documented in the literature as significant risk factors for LBP due to the mechanical stress they impose on the lumbar spine [44]. Comparing these findings with similar studies, it is evident that prolonged standing, bending, and lifting are common risk factors for LBP. For instance, a study by Wai et al. (2010) found that prolonged standing and heavy lifting were associated with an increased risk of LBP among workers in various occupational settings [45]. Similarly, a study conducted by da Costa and Vieira (2010) highlighted that manual handling tasks, such as lifting and carrying heavy objects, significantly contribute to the development of musculoskeletal disorders, including LBP [29]. The significant correlation between LBP and ergonomic risk factors such as standing, bending, and lifting underscores the need for targeted interventions.

Implementing ergonomic training programs and providing support mechanisms, such as adjustable workstations and lifting aids, could mitigate these risks. Additionally, promoting regular breaks and encouraging proper lifting techniques can help reduce the incidence of LBP among workers [46]. Furthermore, the high prevalence of LBP associated with carrying objects above shoulder height ($n$ = 173, 99.43%; $p < 0.001$) is particularly concerning. This task places considerable strain on the back and shoulders, potentially leading to both acute and chronic pain. This finding is supported by the work Wai et al. (2010), which identified overhead lifting as a significant risk factor for LBP and shoulder injuries in industrial workers [45].

Several significant risk factors for LBP, including working overtime (AOR = 1.13, $p < 0.001$; 95% CI: 0.07–0.22), performing repetitive tasks (AOR = 8.06, $p < 0.001$; 95% CI: 4.67–13.93), bending (AOR = 7.77, $p < 0.001$; 95% CI: 3.97–15.22), and twisting (AOR = 3.32, $p < 0.001$; 95% CI: 1.83–6.03) for extended periods while completing tasks, were identified. These findings are consistent with existing literature that highlights the significant impact of repetitive motion, awkward postures, and prolonged physical exertion on the development of LBP. Similarly, Punnett and Wegman (2004) identified prolonged bending and twisting as key risk factors for LBP among workers in various occupational settings [44]. Working overtime was also shown to be a significant risk factor for LBP in this study. This finding aligns with the studies that demonstrated that extended working hours contribute to increased physical and mental fatigue, thereby elevating the risk of musculoskeletal pain, including LBP [28,47,48]. The association between working overtime and LBP suggests the importance of implementing policies that limit excessive work hours to protect workers' health in African mining sectors. The high odds ratio for repetitive tasks (AOR = 8.06) indicates a strong association with LBP, which is corroborated by previous studies. For example, the systematic review by da Costa and Vieira (2010) concluded that jobs requiring repetitive hand and arm movements significantly increase the risk of LBP and other musculoskeletal disorders [39]. This highlights the necessity of ergonomic interventions to reduce repetitive strain in the workplace, such as mining. Bending and twisting for extended periods also showed strong associations with LBP, with AORs of 7.77 and 3.32, respectively. The biomechanical strain caused by these activities can lead to significant stress on the lumbar spine, resulting in pain and injury.

## 5. Conclusions

Our study highlights the significant burden of LBP among nickel mineworkers in Zimbabwe and suggests the importance of healthy living in mitigating LBP-related symptoms. The findings are consistent with existing literature and suggest that lifestyle interventions could play a crucial role in managing lower back pain. Future research should focus on longitudinal studies to better understand the causal relationships between lifestyle factors and LBP and to develop targeted interventions for high-risk populations.

Our findings further emphasize the need for workplace interventions that address job demands, working hours, and staff shortages to improve workers' health and reduce the incidence of LBP. Implementing ergonomic improvements, enforcing limits on overtime work, and providing training on safe work practices can help mitigate the risk of LBP among miners in African countries. Future research should continue to explore these associations and develop comprehensive strategies to prevent LBP and promote occupational health.

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**Data Availability Statement:** The data presented in this study are available on request from the corresponding author due to the confidentiality and Protection of Personal Information Act.

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## Appendix A

**Table A1.** Workplace-related risk factors associated with lower back pain in the study.

| Workplace-Related Risk Factors | | COR | *p*-Value | 95% CI |
|---|---|---|---|---|
| Work experience | Less than 5 years | | Ref | |
| | 6–15 years | 1.55 | 0.30 | 1.10–1.65 |
| | 16–25 years | 1.70 | 0.21 | 2.34–3.00 |
| | 25 years or more | 1.28 | 0.11 | 0.24–1.45 |
| Part-time work | No | | Ref | |
| | Yes | 0.16 | <0.01 * | 0.09–0.31 |
| Working days a week | Less than 7 days | | Ref | |
| | 7 or more days | 1.68 | 0.02 | 1.09–2.61 |
| Hours per day | 8 h or less | | Ref | |
| | More than 8 h | 7.69 | <0.01 * | 4.93–11.99 |
| Shortage of staff | No | | Ref | |
| | Yes | 0.18 | <0.01 * | 0.12–0.28 |
| Rotation | No | | Ref | |
| | Yes | 1.03 | 0.88 | 0.69–1.53 |
| Resting time | No | | Ref | |
| | Yes | 1.12 | 0.56 | 0.76–1.65 |

* *p*-value statistically significant at 0.05.

**Table A2.** Ergonomic risk factors associated with lower back pain in the study.

| Workplace-Related Risk Factors | | COR | *p*-Value | 95% CI |
|---|---|---|---|---|
| Standing | No | | Ref | |
| | Yes | 7.73 | <0.01 * | 4.97–12.03 |
| Carrying heavy objects | No | | Ref | |
| | Yes | 1.61 | 0.02 | 1.08–2.41 |
| Lifting | No | | Ref | |
| | Yes | 1.39 | 0.48 | 0.56–3.47 |
| Static | No | | Ref | |
| | Yes | 1.19 | 0.39 | 0.80–1.76 |
| Shoulder | No | | Ref | |
| | Yes | 1.32 | 0.19 | 0.34–0.78 |
| Vibration | No | | Ref | |
| | Yes | 1.31 | 0.17 | 0.89–1.94 |
| Heat | No | | Ref | |
| | Yes | 1.33 | 0.17 | 0.89–2.01 |
| Cold | No | | Ref | |
| | Yes | 1.42 | 0.09 | 0.94–2.12 |
| Wet clothes | No | | Ref | |
| | Yes | 1.16 | 0.45 | 0.78–1.73 |

* *p*-value statistically significant at 0.05.

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