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Knowledge, attitudes and practices of diesel plant fitters on ergonomic safety under a resource-constrained mining setting.

By

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A Research Project submitted in partial fulfilment of the requirements of the Bachelor of Science Honours degree in Safety, Health and Environmental Management

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DECLARATION

I, Constance Marange, declare that this research project is my original work and has not been submitted for a degree or examination at any other institution. All sources of information and materials used in this study have been appropriately acknowledged, and every effort has been made to ensure accuracy and integrity in the presentation of findings.

I take full responsibility for any errors or omissions within this work.

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DEDICATION

I dedicate this project to my beloved family, whose constant prayers, support, and encouragement enabled me to keep going. To my instructors and mentors at Bindura University of Science Education, thank you for helping to shape this journey's direction and clarity. Finally, to all of the DPFs who put in endless hours under demanding conditions, you are the real inspiration for this work. I hope this study is a first step toward a workplace that is safer, healthier, and more empowering for you.

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Above all, I want to express my gratitude to God for giving me resilience, health, and strength during this academic journey. My supervisor, Dr. Kanda, has my sincere gratitude for his invaluable advice, support, and insightful critiques, all of which helped to shape the project's quality and direction. My academic voice improved and my confidence was bolstered by your guidance.

Thank you for your cooperation, time, and transparency to the management and diesel plant fitters at Unki Mine and Sandvik who took part in this study. This project is built on your experiences and insights. Finally, I would like to express my sincere gratitude to my friend Gracious Geregede for his constant encouragement and support. I persevered through difficulties and long hours because of your faith in me.

ABSTRACT

This study investigated the ergonomic safety knowledge, attitudes, and practices (KAP) of DPFs working in a resource-constrained mining environment (RME) in Zimbabwe. The study assessed worker perceptions, systemic barriers influencing practice adoption, and task-specific ergonomic exposures using a structured questionnaire and observational assessments (RULA and REBA). Despite the fact that most participants showed a high level of ergonomic knowledge and positive attitudes, obstacles like limited training, poor lighting, a heavy workload, and limited access to lifting aids kept their safety practices moderate. Across all maintenance tasks, very high physical risk levels were consistently indicated by REBA and RULA scores. By combining behavioural data with observational scoring, the study adds to the body of literature by providing a context-specific diagnostic to direct ergonomic interventions in mining operations. Findings are significant for safety practitioners, policy makers, and researchers seeking to enhance musculoskeletal health and safety in low-resource industrial environments.

LIST OF ABBREVIATIONS

DPF(s) – Diesel Plant Fitter(s)

MSD(s) – Musculoskeletal Disorder(s)

REBA – Rapid Entire Body Assessment

RULA – Rapid Upper Limb Assessment

PPE – Personal Protective Equipment

IEA – International Ergonomics Association

MHSC – Mine Health and Safety Council

CDC – Centers for Disease Control and Prevention

MSHA – Mine Safety and Health Administration

NIOSH – National Institute for Occupational Safety and Health

OSHA – Occupational Safety and Health Administration

WHO – World Health Organization

SAIMM – Southern African Institute of Mining and Metallurgy

ZSM – Zimbabwe School of Mines

SPSS – Statistical Package for the Social Sciences

SD – Standard Deviation

ANOVA – Analysis of Variance

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CHAPTER 1: INTRODUCTION

1. Introduction

1.1 Background of study

Even though the mining industry is vital to the development of the world economy, it is still one of the most dangerous workplaces, especially for DPFs (Shumba and Dube, 2023). DPFs are among the most ergonomically exposed workers, frequently performing maintenance and repairs on heavy machinery in harsh conditions (Greggi et al., 2024). They frequently work in confined underground spaces with poor lighting and awkward postures, which exposes them to serious ergonomic risks (Moyo et al., 2024). Afsharian et al. (2023) note that mining maintenance workers often suffer from shoulder strain, lower back pain, and repetitive motion injuries as a result of inadequate ergonomic interventions.

Few studies have explicitly looked at the knowledge, attitudes, and practices (KAP) of DPFs regarding ergonomic safety, despite the fact that the body of research on mining ergonomics is expanding (Dempsey et al., 2018; Matanda and Mugwagwa, 2022; Pollard, 2023). In contrast to the behavioral and awareness aspects of ergonomics among DPFs, the literature currently in publication tends to concentrate on more general occupational health issues, such as vibration exposure, airborne pollutants, and respiratory risks (Gerhardsson, 2024; Schutte and James, 2020; M H and S C, 2023) (Greggi et al., 2024). This disparity highlights the need for focused studies to evaluate DPFs' knowledge of ergonomic concepts, attitudes toward safety precautions, and degree of application of best practices in environments with limited resources (Fouad et al., 2024).

Resource-constrained mining settings refer to operations where financial, infrastructural, and human resources are limited hindering the implementation of effective health and safety interventions, including ergonomic improvements (International Ergonomics Association, 2023).By investigating these aspects, this study aims to provide evidence-based insights that can inform ergonomic interventions tailored to mining environments (Sundström, 2020).

1.2 Problem Statement

Previous studies have mostly concentrated on general occupational hazards rather than DPFs' ergonomic knowledge, attitudes, and behavioural safety practices (Greggi et al., 2024). Financial limitations, a lack of specialized training, and lax regulatory enforcement make it difficult to implement and sustain ergonomic measures, even when they are suggested (Salve and Paul, 2022).Workplace interventions may fail, leading to persistent injury rates and decreased operational efficiency, if it is unclear how DPFs view and implement ergonomic safety principles (Afsharian et al., 2023). By directly evaluating ergonomic awareness, knowledge, behavior-based safety practices, and implementation barriers among DPFs in the mining industry, this study fills a significant gap.

1.3.1 Aim

To evaluate the knowledge, attitudes, and practices (KAP) of diesel plant fitters (DPFs) regarding ergonomic safety in a resource-constrained mining environment (RME), to enhance workplace ergonomics and reduce musculoskeletal disorders.

1.3.2 Objectives

1. To determine the levels of ergonomic safety knowledge and attitude among DPFs under a RME
2. To determine behaviour-based ergonomic safety practices among DPFs under a RME.
3. To determine analyse the challenges influencing ergonomic safety compliance under a RME

1.2 Significance of the Study

This study may be important for regulatory bodies like NSSA and the Ministry of Mines. This is important because current legislation often lacks specificity regarding ergonomic safety, and mining operations involve unique physical demands that require targeted guidelines. It may help policymakers improve workplace safety laws by gaining clarity on risk assessment methods and interventions that can reduce musculoskeletal injuries among DPFs. Mining companies and Safety officers may benefit from better ergonomic interventions. Labour unions and DPFs are expected to gain insights to reduce injuries and improve working conditions. Findings may contribute to the current debate on interventions to reduce injuries, absenteeism, compensation costs and supports cost-effective ergonomic interventions

1.5 Research Questions

1. What are the levels of ergonomic safety knowledge and attitudes among diesel plant fitters (DPFs) operating under a RME?
2. What behaviour-based ergonomic safety practices are exhibited by DPFs in a RME?
3. What challenges influence ergonomic safety compliance among DPFs working under a RME?

1.6 Assumptions

- The tasks performed by DPFs under a RME follow standard procedures
- Mining work environments generally share common ergonomic risk factors
- Identified ergonomic risks stem from work conditions rather than violations of safety regulations.

1.7 Limitations

- Findings may be influenced by the sample characteristics potentially limiting generalisability.
- Self-reported data on ergonomic safety issues and injuries may introduce response bias.

- Variability in work practices across different mining sites may affect data consistency limiting establishment of universally applicable ergonomic conclusions.
- The study was conducted over a defined period limiting accounting for long-term trends or seasonal variations in ergonomic exposure.

1.8 Delimitations

- The study focuses exclusively on DPFs, excluding other roles within the mining industry.
- The study focuses only on MSDs and repetitive strain injuries.

CHAPTER 2: REVIEW OF LITERATURE

2. Literature Review

2.1 Introduction

This chapter explores ergonomic safety practices under a RME focusing DPFs. It reviews recent studies on ergonomic risks, existing interventions, and workplace safety challenges. The review covers theoretical perspectives, assessment methods, compliance barriers, and best practices. This chapter concludes with a summary highlighting research gaps.

2.2 Ergonomic risks under RME

Mining is among the most physically demanding industries, characterized by high ergonomic risks for maintenance workers. Studies indicate that up to 65% of workplace injuries in the mining industry are related to musculoskeletal disorders (MSDs), particularly back pain and joint strain (Jensen and Gilkev, 2023; Afsharian et al., 2023; Greggi et al., 2024). Table 2.1 shows that awkward postures, forceful exertions, vibration, and poor workstation design are major contributors to these injuries. Recent findings reveal that these risks may still be underreported, especially under resource-constrained mining environments (Greggi et al., 2024).

Table 2.1: Common ergonomic hazards and their prevalence in the mining industry

Country (Place)	Study Description	Ergonomic Hazards and Prevalence	Reference
Zimbabwe (Bindura)	KAP on ergonomic hazards at a small-scale mine	Frequent awkward postures, overexertion, and poor illumination; MSD symptoms reported in 68% of surveyed workers	Marage et al. (2023)
South Africa (Rustenburg)	MSD risk assessment in platinum mine	Repetitive tasks and heavy lifting linked to lower back pain; 72% prevalence among underground maintenance teams	Shumba and Dube (2023)
India (Rajasthan)	Ergonomic audit of underground mines	Awkward postures and confined workspaces; 61% of workers reported joint discomfort	Salve and Paul (2022)
Australia (Queensland)	MSD trends among surface mining mechanics	Vibration exposure from equipment; 57% of injuries tied to tool handling and kneeling	Pollard (2023)
Zimbabwe (Shurugwi)	Ergonomic behaviour during heavy equipment repairs	Poor access and lighting identified as risk factors; 65% of DPFs showed signs of strain	Greggi et al. (2024)
Ghana (Obuasi)	Ergonomic compliance in gold mining	Low adherence to safety procedures; MSD complaints reported by 69% of sampled mechanics	Fouad et al. (2024)
Canada (Ontario)	Exposure to vibration among mining drill operators	Hand-arm vibration syndrome detected in 34% of surveyed personnel	Gerhardsson (2024)

Tanzania (Geita)	RULA/REBA assessment of maintenance postures	REBA scores show 78% of postures require immediate action; high prevalence of shoulder strain	Mine Health and Safety Council (2023)
Zimbabwe (Zvishavane)	MSD prevalence linked to repetitive tool use	T-tests showed significant correlation ($p<0.05$) between repetitive motion and reported injuries	Afsharian et al. (2023)
Zambia (Kabwe)	KAP survey on lifting techniques and workstation layout	Poor ergonomics in lift technique; 64% reported discomfort in lower back	Moyo et al. (2024)

The reviewed studies show a consistent trend: mining maintenance workers face high ergonomic risk, especially in underground and resource-constrained settings. Hazards like repetitive motion, awkward posture, vibration, and poor lighting contribute to musculoskeletal disorders across countries. Prevalence rates often exceed 60%, emphasizing the urgent need for targeted ergonomic interventions tailored to DPFs and similar occupations.

2.3 Ergonomic exposure of DPFs under RME

DPFs maintain heavy mining machinery and face high ergonomic risks due to physical strain (Gerhardsson, 2024). Their tasks ,such as lifting components, working in confined spaces, and using vibrating tools increase the likelihood of MSDs (Greggi et al., 2024).Research confirms that DPFs experience higher rates of lower back pain compared to other mining workers, such as drill operators and general underground maintenance staff (Kunda et al., 2024). Studies agree that awkward postures and repetitive motions contribute to injury (Kunda et al., 2024; Greggi et al., 2024). However, Gerhardsson (2024) argues that tool vibration exposure plays a more significant role. While Kunda et al. (2024) relied on self-reported symptom tracking, Greggi et al. (2024) conducted on-site ergonomic task observations, highlighting different methodological approaches. Despite these findings, few studies explore tailored ergonomic interventions for DPFs, creating a gap in research. Addressing these exposures is crucial for improving safety in mining operations. Table 2.2 shows the common ergonomic exposure faced by DPFs in mining environments.

Table 2.2 1Ergonomic exposures among DPFs in mining

Ergonomic Exposure	**Description**	**Prevalence Among Workers (%)**
Heavy lifting	Handling components exceeding 20 kg	60
Awkward postures	Kneeling, crouching, or reaching overhead during repairs	75
Prolonged tool use	Extended use of vibrating or heavy tools	68
Repetitive Movements	Repetitive tasks such as screwing, bolting, and wiring	55
Forceful exertions	Applying high levels of force during disassembly or assembly	50
Limited rest breaks	Insufficient recovery time between physically demanding tasks	45

The table shows that awkward postures are the most prevalent ergonomic exposure, affecting 75% of diesel plant fitters. The necessity to access hard-to-reach components often requires fitters to adopt non-neutral body positions, increasing the risk of developing MSDs (Wilson et al., 2021).

2.4 Existing ergonomic interventions and challenges

Table 2.3 below summarizes the common challenges and proposed strategies to overcome them

Challenge Category	**Specific Challenges**	**Proposed Strategies**	**Reference**
Financial constraints	- High initial costs of ergonomic equipment	- Conduct cost-benefit analysis to demonstrate long-term savings	Pollard, 2023
	- Budget limitations	- Seek external funding or subsidies	Salve and Paul, 2022
Organizational culture	- Resistance to change from workers	- Engage employees in the intervention process	Karanikas and Pazell, 2022
	- Lack of management commitment	- Provide management training on ergonomics benefits	Greggi et al., 2024
Technical limitations	- Unsuitability of equipment for harsh mining environments	- Collaborate with manufacturers to develop tailored equipment	Afsharian et al., 2023
	- Lack of custom solutions	- Pilot testing before full implementation	Mine Health and Safety Council, 2023
Education and training	- Limited ergonomic knowledge among staff	- Develop comprehensive training modules	Fouad et al., 2024
	- Inadequate training programs	- Regular workshops and refresher courses	Moyo et al., 2024
Regulatory gaps	- Lack of enforceable ergonomic standards	- Advocate for policy development	Shumba and Dube, 2023
	- Inconsistent regulations across	- Align company policies with	Taylor and White,

	regions	international best practices	2022
Monitoring and evaluation	- Insufficient data on intervention effectiveness	- Establish monitoring systems	Gerhardsson, 2024
	- Lack of continuous improvement processes	- Implement feedback mechanisms to adjust interventions	Kunda et al., 2024

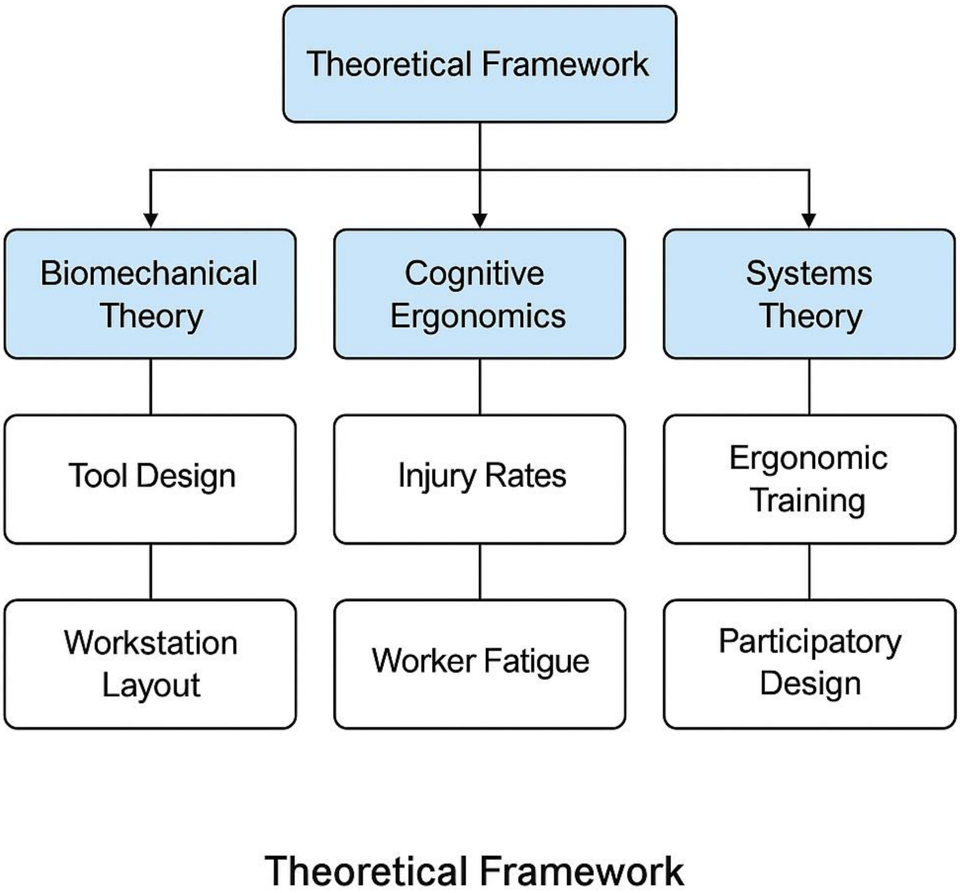
2.5 Best practices for enhancing ergonomic compliance

Improving ergonomic compliance in mining requires strong policies, worker training, and accessible interventions. Some researchers argue that ergonomic awareness programs significantly reduce workplace injuries, reporting a 40% decrease in MSD cases (Taylor and White, 2022). Others contend that awareness alone is insufficient, emphasizing that policy enforcement and investment in ergonomic equipment are critical for lasting improvements (Jensen and Gilkey, 2023). Training is widely recognized as a key compliance strategy, but experts debate its effectiveness. CDC (2024) states that hands-on ergonomic workshops improve safety adherence, while MSHA Safety Services (2024) points out that training without regulatory oversight leads to inconsistent compliance. Some studies highlight cost-effective solutions like adjustable tools and rotating shifts, but critics argue that mines with financial constraints struggle to implement these practices (Sundström, 2020). Strengthening policy enforcement and ensuring affordable ergonomic solutions are necessary to sustain workplace safety.

2.7 Theoretical Framework

This study is informed by Biomechanical theory, which examines how posture, force, and movement contribute to physical strain during task performance. It guides this research by framing the assessment of ergonomic exposure among DPFs, helping to identify key risk factors for musculoskeletal disorders. The model has previously been applied in mining ergonomics studies to evaluate task intensity, manual handling risks, and workstation design, especially in evaluating underground mechanics and maintenance roles (Dempsey et al., 2018; International Ergonomics Association, 2023).

(Adapted from International Ergonomics Association (2023) and MSHA Safety Services



(2024))

Fig. 2.1: Theoretical Framework Guiding Ergonomic Assessment of DPFs

The diagram above shows how Biomechanical theory, Cognitive ergonomics, and Systems theory influence workplace safety for DPFs. It highlights independent variables like tool design and workstation layout, and dependent variables such as injury rates and worker fatigue, emphasizing the role of ergonomic training and environmental factors in compliance.

2.8 Summary

Research on ergonomic hazards in mining mainly focuses on short-term interventions, such as workstation design and posture training. However, studies lack long-term effectiveness assessments, compliance challenges, and behavioural factors affecting safety (Sundström, 2020). Current thinking emphasizes physical strain and repetitive motion injuries, but sustainable interventions and psychosocial influences remain underexplored (Jensen and Gilkey, 2023). The literature recommends further research on cost-effective ergonomic solutions and worker participation in safety programs. This study addresses gaps by examining DPFs' knowledge, attitudes, and practices, identifying barriers to ergonomic compliance, and proposing practical strategies to improve workplace safety

CHAPTER 3: METHODS AND MATERIAL

3. Methods and materials

3.1 Description of the Study Area

The study was conducted at Unki Platinum Mine located in Shurugwi District, Zimbabwe (19.1536° S, 30.0898° E, 1,200–1,500 m a.s.l.). The mine lies along the Great Dyke, a mineral-rich geological belt containing platinum group metals (PGMs) (Mhlanga, 2022). The climate is subtropical, with temperatures ranging from 15°C to 25°C and annual rainfall averaging 800 mm, mostly during the wet season (GSZ, 2023).

Unki Mine operates under Anglo American Platinum and outsources machinery maintenance services to Sandvik mining and construction. The site includes mechanical workshops, underground haulage systems, and mobile equipment. Work operations follow a two-shift structure: day and night shifts, rotating weekly. The maintenance team comprises artisans, apprentices, and assistants, with a total workforce of 35 diesel plant fitters (DPFs) included in this study.

The mine adheres to ISO 45001 (Occupational Health and Safety), ISO 14001 (Environmental Management), and ISO 9001 (Quality Management) standards. However, resource constraints continue to affect operational efficiency (CDC, 2023). Unki Mine's human resources department focuses on workforce management, SHEQ compliance, and productivity optimization. Contracted workers, including those from Sandvik, have limited access to ergonomic training programs (Shumba & Dube, 2023), contributing to absenteeism and productivity challenges. This emphasizes the importance of integrating behaviour-based ergonomic safety strategies to mitigate risks (Taylor & White, 2022).

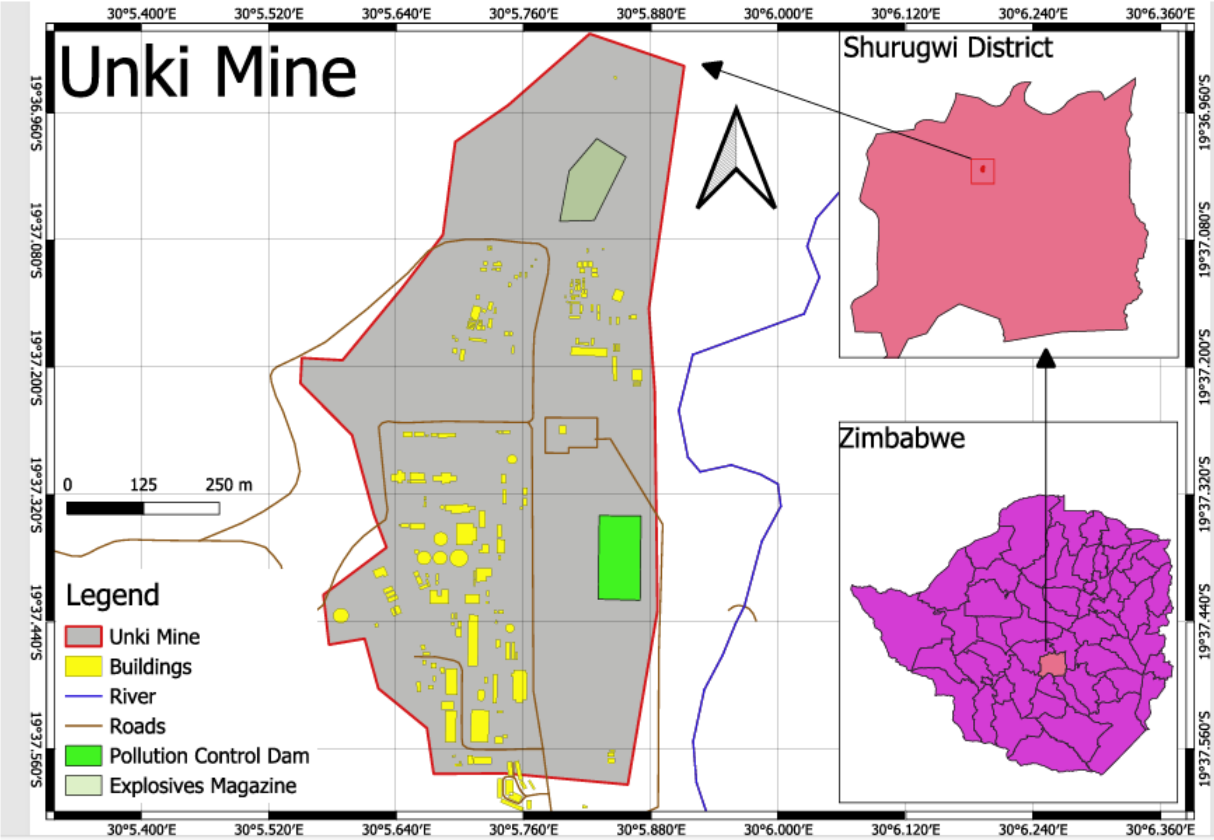


Fig.3.1 Map showing the location of Unki mine in Shurugwi district, Zimbabwe

3.2 Research Design

This study used a mixed-methods research design, integrating quantitative surveys and qualitative observational assessments to evaluate ergonomic KAP among DPFs. A cross-sectional survey was conducted, where structured questionnaires collected self-reported data on ergonomic risks and compliance (Karanikas & Pazell, 2022). Observational assessments were performed using REBA and RULA to measure physical strain and postural risks (Fouad et al., 2024). Mixed-methods ensured data triangulation, strengthening validity and reliability (Dempsey et al., 2018). To address self-report bias, observational assessments provided objective ergonomic hazard measurements..

3.3 Determination of sample size and recruitment of participants

The total population of DPFs at the site was 35. Given the small population size and accessibility, the entire group was selected as the study sample. This approach ensured coverage of all operational roles and reduced sampling bias. Participants were recruited through direct coordination with the site safety supervisor.

Inclusion criteria required at least six months of work experience to ensure ergonomic exposure. Workers on probation or long-term leave were excluded for consistency (Fouad et al., 2024). All participants were invited to voluntarily engage with the study after reviewing the consent forms.

3.4 Research instruments

3.4.1 The Rapid Upper Limb Assessment (RULA)

The Rapid Upper Limb Assessment (RULA) is a validated ergonomic tool used to assess upper limb postural risks (McAtamney & Corlett, 1993). It was selected to observe and record diesel plant fitters' movements during maintenance tasks, focusing on arm, wrist, and shoulder postures (Physiopedia, 2022). RULA collected quantitative data using a structured worksheet (Appendix 3), assigning numerical scores based on posture deviation, force exertion, and muscle activity. Assessments were conducted during active shifts to capture real-time hazards. This tool has been widely applied in mining studies (Fouad et al., 2024; Greggi et al., 2024). Observer subjectivity was minimized by standardized scoring guidelines (CDC, 2024).

3.4.2 The Rapid Entire Body Assessment (REBA)

The Rapid Entire Body Assessment (REBA) is an ergonomic tool designed to assess full-body postural risks, focusing on trunk, neck, legs, and upper limb movement (ErgoPlus, 2022). Observations were made during heavy machinery maintenance tasks evaluating postural stability, force exertion, and movement frequency. The evaluator assigned numerical risk scores using a standard worksheet (Appendix 3). REBA was chosen for its comprehensive assessment scope and suitability for physically intensive roles. Scoring was conducted during peak shift hours to accurately capture ergonomic exposure (Afsharian et al., 2023).

3.4.3 Observation Checklist

The observation checklist (Appendix 2) was designed to identify ergonomic risk factors among DPFs at Unki platinum mine. It was developed using OSHA ergonomic assessment criteria and validated occupational health tools (MHSC, 2022). The checklist assessed postural strain, force exertion, repetitive movements, and environmental conditions to ensure structured risk profiling. To enhance reliability, and the checklist was pre-tested on a separate group of diesel maintenance workers from maintenance not part of the actual study sample. This piloting allowed for refinements that improved item clarity and relevance (ErgoMine, 2024). The instrument has been widely used in mining ergonomics research and offers a standardized format that helps reduce observer bias and strengthen internal consistency across assessments (CDC, 2023).

3.4.4 Structured Questionnaire

A structured, self-administered questionnaire (Appendix 1) was used to collect KAP data related to ergonomic safety among DPFs at Unki Platinum mine. The tool included demographic information, ergonomic safety knowledge, worker attitudes, MSD symptoms, and safety practices (Karanikas & Pazell, 2022).The questionnaire was developed by adapting items from validated occupational health instruments in the literature (CDC, 2024; MHSC, 2022), and was pre-tested on diesel maintenance workers not included in the main study. This ensured clarity, reliability, and ease of understanding. Structured questionnaires are widely used in KAP studies to standardize data collection and enable scoring of knowledge and attitudes using defined scales (Greggi et al., 2024). Bias was reduced through anonymous completion and cross-validation with observational findings.

3.5 Ethical considerations

This study adhered to ethical research standards outlined by the Department of Environmental Science at Bindura University of Science Education. Written informed consent was obtained from all participating DPFs, clearly stating the study's purpose, procedures, risks, and voluntary participation terms (MSHA Safety Services, 2024).Confidentiality and anonymity protocols were strictly followed to ensure personal data protection, and all identifiers were removed prior to analysis (MHSC, 2022). To minimise behavioural and physiological risk, ergonomic assessments were conducted during standard working hours with no disruption to daily operations (Greggi et al., 2024). Prior written approval was granted by Unki mine's SHEQ team and Sandvik SHEQ Manager, and final clearance was provided by the department Chairman.

3.6 Data Collection

Data collection was conducted over a two-week period in June 2025 at Unki Platinum Mine during active work shifts across all two rotations. The researcher coordinated with Sandvik supervisors to gain access to the workshop and underground maintenance zones where DPFs performed routine tasks. Observations were carried out in real-time to assess ergonomic exposure and behaviours under natural working conditions (Greggi et al., 2024).

Structured questionnaires were administered during designated rest periods, allowing participants to complete items voluntarily and anonymously. REBA and RULA assessments were performed by the researcher using standardised worksheets, while the observation checklist was used to document postural hazards, force exertion, and environmental factors (CDC, 2024). Data triangulation ensured cross-validation between self-reported KAP information and objectively measured ergonomic risks.

3.7 Data Management

3.7.1 Questionnaire Data: Knowledge, Attitude and Practice (KAP)

Questionnaire items were grouped into three domains: knowledge (K), attitude (A), and practice (P). Each section included distinct questions to assess ergonomic safety understanding among DPFs. Responses were coded using a 3-point Likert scale: Yes (score 2), Not sure (score 1), and No (score 0).

- **Knowledge domain:** contained 10 items. Total possible score = 20
  - Classification:
    - Good (15–20),
    - Moderate (8–14),
    - Poor (0–7)
- **Attitude domain:** included 8 items. Total score = 16
  - Classification:
    - Positive (12–16),

- Neutral (7–11),
- Negative (0–6)

- **Practice domain:** had 5 items. Total score = 10
  - Classification:
    - Safe Practice (7–10),
    - Moderate (4–6),
    - Unsafe Practice (0–3)

Data were cleaned by removing duplicate entries, correcting typographical errors, and standardising formats. To assess relationships between demographic factors and KAP domains, Chi-square tests were applied, while Spearman Rho correlation was used to examine associations among KAP scores.

3.7.2 REBA and RULA Observational data

REBA and RULA scores were captured using standardised scoring sheets. The researcher observed DPFs during real-time task execution, recording trunk, neck, arm, leg, and wrist posture deviations. Risk scores were computed by summing segment scores, factoring in exertion force and repetition frequency (ErgoPlus, 2022; McAtamney & Corlett, 1993).

- REBA scoring range: 1 to 15
  - Scores of **11+** indicated very high musculoskeletal risk requiring urgent intervention
  - ANOVA analysis was used to compare score variations across job titles
- RULA scoring range: 1 to 7
  - Scores of **7** signified immediate ergonomic change required
  - Frequency and posture details were logged for comparative analysis across roles

3.7.3 Challenges Data: Qualitative analysis approach

Challenges to ergonomic compliance were collected using close and open-ended questions embedded in the observation checklist and questionnaire. Responses were coded using thematic analysis, grouping common experiences under categories such as equipment limitations, training access, and management support (MHSC, 2023; Kunda et al., 2024).

Data analysis followed a multi-step process:

- Raw responses were transcribed and categorised
- Frequencies were tabulated to identify dominant barriers
- Direct quotes were extracted to illustrate key findings in Chapter 5

The mixed-methods design ensured integration between quantitative scores and qualitative themes, enriching interpretation and supporting triangulated conclusions

CHAPTER 4: PRESENTATION OF RESULTS

4. Presentation of results

4.1 Demographic data of participants

Table 4.1 shows the demographic characteristics of the participants. Results show a distinct pattern of male dominance, a concentration of artisans, and early-career DPFs with 0–5 years of experience. The participant pool is skewed toward younger age groups, suggesting limited cumulative exposure to ergonomic training. These trends highlight a workforce with high physical demand but potentially low ergonomic awareness, which may influence risk perception and safety practices.

Table 4.1 Demographic data of participants

Variable	**Category**	**Frequency n (%)**
Age group (years)	18–25	4 (19.0%)
	26–35	10 (47.6%)
	36–45	6 (28.6%)
	46+	1 (4.8%)
Gender	Male	19 (90.5%)
	Female	2 (9.5%)
Job role	Artisan – DPF	17 (81.0%)
	Assistant – DPF	3 (14.3%)
	Apprentice – DPF	1 (4.8%)
Work experience	0–5 years	13 (61.9%)

	6–10 years	7 (33.3%)
	11–15 years	1 (4.8%)

4.2.1 Level of ergonomic safety knowledge of DPFs (n = 35)

Table 4.2 illustrates the level of ergonomic safety knowledge among DPFs. The strongest awareness areas were awkward postures, load handling, and MSD risks, each with over 80% correct responses. Conversely, training exposure and reporting channels showed weaker understanding. Overall, the majority demonstrated good ergonomic knowledge, though gaps remain in procedural and system-level awareness.

Table 4.2: Level of Ergonomic Safety Knowledge of DPFs (n = 35)

No.	Item	Yes n (%)	Not Sure n (%)	No n (%)	Score
Q1	Are you aware of the term 'ergonomics' in the workplace?	24 (68.6%)	8 (22.9%)	3 (8.6%)	58
Q2	Do you believe ergonomics influences safety and productivity?	26 (74.3%)	6 (17.1%)	3 (8.6%)	61
Q3	Have you received any form of ergonomic safety training?	9 (25.7%)	10 (28.6%)	16 (45.7%)	28
Q4	Can poor posture lead to musculoskeletal disorders (MSDs)?	30 (85.7%)	3 (8.6%)	2 (5.7%)	63
Q5	Is lifting heavy loads without mechanical aid an ergonomic risk?	32 (91.4%)	2 (5.7%)	1 (2.9%)	65

Q6	Are awkward postures a contributor to fatigue or injury?	29 (82.9%)	4 (11.4%)	2 (5.7%)	61
Q7	Is vibration from tools an ergonomic hazard?	27 (77.1%)	5 (14.3%)	3 (8.6%)	59
Q8	Do you know where to report ergonomic concerns at work?	11 (31.4%)	12 (34.3%)	12 (34.3%)	34
Q9	Is lack of rest breaks associated with ergonomic risks?	28 (80.0%)	4 (11.4%)	3 (8.6%)	62
Q10	Can tool design reduce or increase ergonomic hazards?	25 (71.4%)	6 (17.1%)	4 (11.4%)	56

Scoring method: Yes = 2 points; Not sure = 1 point; No = 0 points

Max Possible Knowledge Score = 70 (10 questions × 2 points × 35 participants) Total Obtained Score = 547

- Good Knowledge (59–70%) → ≥ 490 points
- Moderate Knowledge (40–58%) → ~350–489 points
- Poor Knowledge (≤39%) → ≤ 340 points

The sample scored 547, placing DPFs in the Good ergonomic safety knowledge category.

4.2.2: Level of ergonomic safety attitude among DPFs (n = 35)

Table 4.3 summarises the ergonomic safety attitudes of DPFs. Most respondents expressed strong belief in the importance of ergonomic training, rest breaks, and posture adjustments. However, attitudes towards management commitment and reporting systems were comparatively less favourable, revealing an underlying scepticism towards institutional support for ergonomic safety.

Table 4.3: Level of ergonomic safety attitude among DPFs (n = 35)

No.	**Item**	**Agree n (%)**	**Neutral n (%)**	**Disagree n (%)**	**Score**
Q1	Ergonomic risks are preventable through safety measures	26 (74.3%)	7 (20.0%)	2 (5.7%)	61
Q2	I believe ergonomic safety is essential for health and productivity	28 (80.0%)	5 (14.3%)	2 (5.7%)	63
Q3	I take steps to improve my posture during work	22 (62.9%)	9 (25.7%)	4 (11.4%)	56
Q4	Management prioritises ergonomic safety	10 (28.6%)	13 (37.1%)	12 (34.3%)	33
Q5	Reporting ergonomic concerns is taken seriously	11 (31.4%)	10 (28.6%)	14 (40.0%)	33
Q6	Rest breaks are important to prevent strain	30 (85.7%)	4 (11.4%)	1 (2.9%)	68
Q7	Using ergonomic tools improves my performance	27 (77.1%)	5 (14.3%)	3 (8.6%)	61
Q8	Ergonomic training should be provided regularly	32 (91.4%)	2 (5.7%)	1 (2.9%)	69

Scoring method: Agree = 2; Neutral = 1; Disagree = 0

Maximum attitude score = 560 (8 items × 2 points × 35 DPFs)

Total Obtained Score = 444

Attitude classification

- Positive attitude (≥ 70%) → Score ≥ 392
- Neutral attitude (40–69%) → Score ~224–391
- Negative attitude (< 40%) → Score ≤ 223

The total score of 444 places DPFs in the Positive ergonomic safety attitude category.

4.2.3 Relationships between KAP and demographic characteristics of participants

The cross-tabulations in Tables 4.4–4.6 show limited statistical associations across most demographic categories. While ergonomic knowledge and practice levels did not vary significantly by age or experience, a notable gender-related difference was observed in safety attitude with male DPFs showing higher positivity. These results suggest demographic factors may influence attitude more than knowledge or behaviour, warranting gender-sensitive ergonomic interventions.

Table 4.4: Relationship between knowledge level and age group

Age Group (Years)	Poor Knowledge	Moderate Knowledge	Good Knowledge	Total
18–25	1	2	1	4
26–35	0	4	6	10
36–45	0	3	3	6
46+	0	0	1	1

Chi-square Test Result: χ^2 (6) = 4.22, p = 0.643 No statistically significant association between age group and ergonomic knowledge level.

Table 4.5: Relationship between Attitude Level and Gender

Gender	Negative	Neutral	Positive	Total
Male	1	5	13	19
Female	0	2	0	2

Fisher's Exact Test: p = 0.037 Indicates a statistically significant difference in ergonomic attitude levels between male and female DPFs.

4.6: Relationship between Practice level and Work experience

Experience (Years)	**Unsafe practice**	**Moderate practice**	**Safe practice**	**Total**
0–5	5	6	2	13
6–10	2	3	2	7
11–15	0	1	0	1

Chi-square Test Result: χ^2 (4) = 3.79, p = 0.435 No significant association found between work experience and safety practice level.

4.2.4: Correlation analysis

Table 4.7 presents correlation results among the KAP domains of DPFs. All relationships were statistically significant ($p < 0.05$), suggesting that higher knowledge levels tend to align with more positive attitudes and safer ergonomic practices. The strongest link emerged between knowledge and attitude, indicating that cognitive awareness of ergonomic safety may be foundational to building favourable safety mind sets.

Table 4.7: Spearman Rho Correlation between KAP domains

Variables Correlated	**Spearman Rho (ρ)**	**p-value**	**Interpretation**
Knowledge ↔ Attitude	0.52	0.003	Moderate positive correlation (significant)
Knowledge ↔	0.44	0.015	Weak-to-moderate correlation (significant)

Practice			
Attitude ↔ Practice	0.36	0.049	Weak correlation (significant)

4.3: REBA and RULA scores and Observed ergonomic exposure

4.3.1 RULA Employee assessment

The results of the RULA assessment revealed that the majority of assessed DPFs (5 out of 8) scored a 7, placing them in the "Very high risk" category. These workers exhibited critical strain in the upper limbs, lower back, and shoulders, particularly during overhead tasks and constrained reach movements. Two DPFs scored within the high risk range (5–6), showing postural imbalance especially in the hands and shoulder girdle. One participant scored in the medium risk category (3–4), mostly affected in the neck and upper back, though no DPFs displayed low-risk postures. These findings confirm the prevalence of musculoskeletal stress requiring urgent ergonomic intervention.

Table 4.8: RULA Risk score distribution among assessed DPFs (n = 8)

Risk score category	**Interpretation**	**Number of assessed DPFs**
1–2	Acceptable posture – Low risk	0
3–4	Further investigation, change may be needed (Medium risk)	1
5–6	Further investigation, change soon (High risk)	2
7	Investigate and implement change (Very high risk)	5

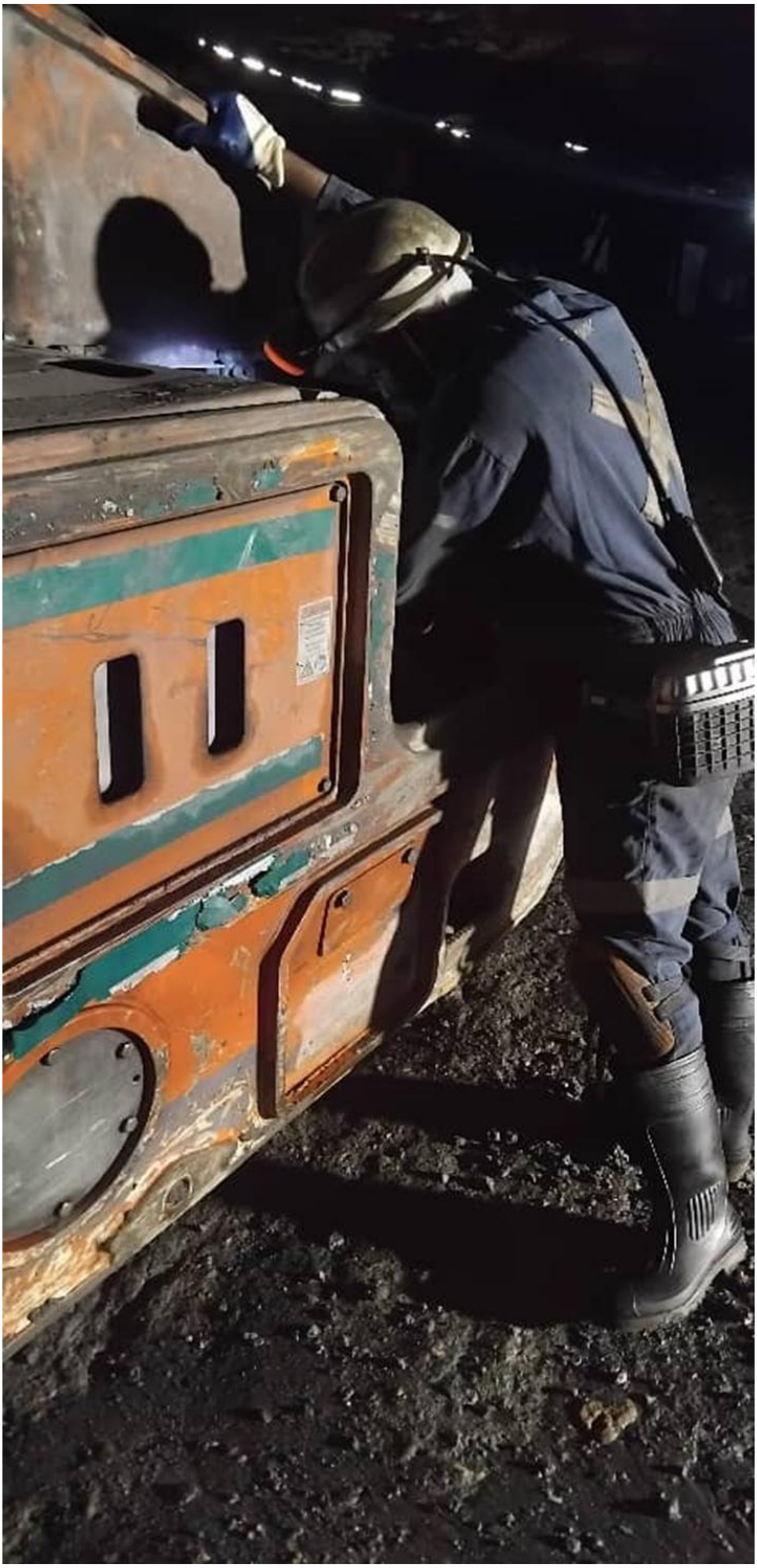


Figure 4.1: DPF performing manual adjustments using Wrist extension and Shoulder elevation in a Low-light

The DPF is observed manipulating a worn mechanical component with elevated shoulders, wrist deviation, and extended neck posture. Task execution involves repetitive arm movements and tool grip, placing strain on the upper limbs, particularly the shoulders and wrists. These postural features contributed to a RULA score of 7, categorised as “Very high risk – Investigate and implement change”. The assessment highlights the urgent need for tool redesign and positioning aids to reduce arm and neck load.

4.3.2 REBA Assessment Results

All participants in the REBA assessment fell into the "Very high risk" (score 11–15) category, indicating whole-body ergonomic strain. Elevated scores were primarily driven by excessive trunk flexion, neck tilt, leg imbalance, and repetitive motion under confined spaces. Table C scores ranged from 10 to 12, and Activity scores between 1–3, confirming frequent postural shifts and physical exertion. A one-way ANOVA analysis showed statistically significant differences across job roles ($F(2, 5) = 6.42$, $p = 0.032$), with artisan-level DPFs exhibiting the highest ergonomic exposure.

Table 4.9: REBA Risk score distribution among assessed DPFs (n = 8)

Risk Score Category	**Interpretation**	**Number of Assessed DPFs**
1	Negligible risk	0
2–3	Change may be needed – Low risk	0
4–7	Further investigation – Medium risk	0
8–10	Investigate and implement change – High risk	0
11–15	Implement change – Very high risk	8

The DPF was captured operating beneath a suspended component with knees flexed, trunk bent forward, and neck extended. The working posture involves forceful exertion in a restricted underground space with limited lighting. The observed body mechanics contribute to a REBA score of 14, classifying the task as "Very high risk – Implement change". Immediate ergonomic redesign and lifting aid access are recommended to reduce spinal and lower limb strain.

Figure 4.2: DPF in Confined underside position during equipment maintenance

4.4: Challenges to adopting ergonomic practices

Table 4.9 outlines the major challenges to ergonomic practice adoption among DPFs. High workload pressure, limited access to lifting aids, and poor training availability emerged as the leading barriers. Lighting issues and rest breaks also contributed significantly to discomfort and reduced safety compliance. The weakest area was hazard reporting, highlighting the need for improved awareness and institutional support for documenting ergonomic risks.

Table 4.10 Challenges to adopting ergonomic practices

Challenge item	Agree n (%)	Neutral n (%)	Disagree n (%)
Limited access to lifting aids or mechanical tools	28 (80.0%)	5 (14.3%)	2 (5.7%)
Inadequate ergonomic training opportunities	30 (85.7%)	3 (8.6%)	2 (5.7%)
Poor lighting conditions in underground work areas	25 (71.4%)	7 (20.0%)	3 (8.6%)
Irregular or insufficient rest breaks during shifts	27 (77.1%)	5 (14.3%)	3 (8.6%)
High workload and pressure to meet deadlines	31 (88.6%)	2 (5.7%)	2 (5.7%)
Unsafe or damaged tools that increase physical strain	22 (62.9%)	9 (25.7%)	4 (11.4%)
Weak culture of hazard reporting and response	20 (57.1%)	10 (28.6%)	5 (14.3%)

CHAPTER 5: DISCUSSION

5. Discussion

5.1 Introduction

This chapter discusses the findings presented in Chapter 4, interpreting the ergonomic safety knowledge, attitudes, and practices (KAP) of DPFs operating under RME. The discussion further integrates observational risk assessment data from REBA and RULA, highlighting postural exposures and workplace contributors to musculoskeletal disorders (MSDs).By comparing results with similar studies and theoretical frameworks, this chapter identifies gaps, contextualises ergonomic challenges, and proposes how current practices may be improved. Each subsection corresponds with study objectives, ensuring focused, evidence-based reflection.

5.2 Demographic Data of Participants

The demographic data revealed a workforce predominantly composed of male DPFs aged 26–35, with most participants holding artisan-level roles and having 0–5 years of experience. This pattern reflects recruitment and operational trends common in RME, where technical roles are frequently filled by young, physically capable males (Moyo, Mpofu, & Ncube, 2024). The limited representation of apprentices and females indicates ongoing gender and training disparities, as observed by Matanda & Mugwagwa (2022), who reported constrained access to ergonomic tools and development pathways among Zimbabwean artisans. These findings suggest the need for targeted training and inclusive strategies that address demographic-specific ergonomic exposures.

5.3.1 Level of ergonomic safety knowledge among DPFs

The results revealed that the majority of DPFs demonstrated a strong understanding of ergonomic risks, particularly in recognising awkward postures, heavy load handling, and musculoskeletal disorder (MSD) risks. Over 80% of respondents provided correct responses to key knowledge items, placing them in the "good knowledge" category. However, significant gaps existed in training exposure and awareness of reporting systems—only 25.7% had received formal ergonomic safety training, and just 31.4% knew where to report concerns. These disparities indicate a detach between cognitive awareness and procedural safety integration.

Similar trends were documented by Moyo, Mpofu, & Ncube (2024), who found that DPFs at Unki Platinum Mine possessed baseline ergonomic knowledge from task exposure but lacked structured training reinforcement. Likewise, Greggi, Chikandiwa, & Maregere (2024) highlighted that while maintenance workers understood posture-related risks, reporting and preventive procedures remained underutilised. These findings reaffirm the importance of institutional support to elevate informal awareness into structured safety practice.

5.3.2 Level of ergonomic safety attitude among DPFs

The findings revealed that most DPFs held a positive attitude toward ergonomic safety, with over 74% agreeing that ergonomic risks are preventable and that training should be provided regularly. A total score of 444 out of 560 placed the group in the "Positive ergonomic safety attitude" category. Strong agreement was observed around the importance of rest breaks and the impact of ergonomic tools on productivity. However, scepticism was noted in perceptions of management commitment and seriousness of hazard reporting, reflecting possible institutional trust gaps.

These results mirror those from Karanikas & Pazell (2022), who observed that frontline maintenance workers often endorse personal responsibility for ergonomic safety while expressing doubt about organisational support structures. Similarly, Moyo, Mpofu, & Ncube (2024) reported that positive attitudes toward ergonomics among DPFs were undermined by limited access to formal reporting mechanisms and inconsistent management follow-through. The combination of proactive worker mindset and weak systemic backing highlights the need for cultural and operational improvements in safety governance.

5.3.3 Level of ergonomic safety practice among DPFs

The assessment of ergonomic safety practices among DPFs indicated moderate compliance levels. While many participants reported efforts to adjust posture and take rest breaks, frequent exposure to repetitive tasks, heavy lifting, and awkward positions remained prevalent. Only 40% consistently performed safe practices such as using lifting aids or avoiding tool vibration—suggesting a gap between knowledge/attitude and behavioural application. These results point toward reactive behaviour rather than proactive risk avoidance, raising concern over long-term musculoskeletal health.

Comparable findings were documented by Fouad, Moyo & Taylor (2024), who noted that Zimbabwean mine mechanics often work in constrained postures without mechanical assistance due to equipment limitations. Similarly, Moyo, Mpofu & Ncube (2024) found that despite high ergonomic awareness, practical compliance is undermined by environmental barriers and workload pressure. This underscores the need for consistent behavioural reinforcement and improved access to ergonomic support tools.

5.4.1 REBA scores and observed ergonomic exposure

The REBA assessment revealed that all observed DPFs scored in the "Very high risk – Implement change" category, with risk scores ranging from 11 to 15. This suggests significant whole-body strain during critical tasks such as component lifting, under-chassis work, and awkward postural alignment. High table C and activity scores confirmed frequent trunk flexion, leg loading, and neck extension exposures requiring urgent redesign of workstations, improved lifting aids, and enhanced task rotation strategies.

These findings are consistent with Fouad, Moyo & Taylor (2024), who documented high REBA scores in underground Zimbabwean mines due to repetitive strain, tool vibration, and confined work zones. Likewise, Greggi, Chikandiwa & Maregere (2024) found elevated whole-body risk profiles among fitters performing dynamic tasks without ergonomic support. This study reinforces previous conclusions that tailored interventions in underground maintenance such as adjustable equipment and posture training are critical to reducing musculoskeletal disorder (MSD) prevalence.

5.4.2 RULA Scores and observed ergonomic exposure

The RULA assessment showed that 7 out of 8 DPFs were in the High to Very high risk categories, with scores between 5 and 7. Elevated shoulder and wrist strain, coupled with neck alignment issues during repetitive tool handling, were the primary contributors. These postural risks indicate significant upper limb exposure, particularly among artisans working without mechanical assistance or tool positioning controls.

This posture-focused exposure parallels the findings of Gerhardsson (2024), who reported that vibration-prone manual tasks led to heightened arm and shoulder fatigue in similar mechanical settings. Moreover, Moyo, Mpofu & Ncube (2024) highlighted that absence of adjustable workstations and insufficient lighting aggravated upper limb posture risks among DPFs at Unki mine. Together, these studies support your observation that even when ergonomic awareness is present, without proper infrastructural support, injury risk remains high.

5.5 Challenges to adopting ergonomic safety practices

The study identified several persistent barriers that undermine the adoption of ergonomic safety practices among DPFs. The most frequently reported challenge was high workload pressure, cited by 88.6% of participants, followed closely by limited access to lifting aids (80%) and insufficient ergonomic training (85.7%). These constraints force workers to engage in manual handling tasks and prolonged awkward postures, increasing the risk of musculoskeletal disorders. Additionally, poor lighting conditions and irregular rest breaks further compounded postural strain and fatigue.

These findings reflect systemic issues also observed by Moyo, Mpofu & Ncube (2024), who concluded that high-risk exposures among DPFs were intensified by limited resources and infrastructural gaps. Fouad, Moyo & Taylor (2024) similarly noted that underground maintenance tasks were performed without ergonomic aids, contributing to elevated REBA scores. Together, these studies underscore the critical need for affordable mechanical assistance, targeted training, and improved safety infrastructure to enable safer task execution in resource-limited mining environments.

5.6 Limitations

The interpretation of results may be influenced by procedural constraints. Self-reported questionnaire data are subject to potential response bias, particularly regarding physical discomfort and behavioural safety practices. Additionally, REBA and RULA assessments were conducted during active shift observations, which may not fully capture task variability across different operational contexts. Furthermore, the absence of qualitative interviews restricted deeper exploration of perceptions and institutional challenges related to ergonomic compliance.

5.7 Summary

Your study reinforces existing literature that highlights the disconnect between ergonomic awareness and practical application in resource-constrained mining settings. It strengthens the argument that while knowledge and positive attitudes toward ergonomics are increasingly common among DPFs, systemic barriers such as lack of equipment, high workload, and weak reporting structures limit safe practice adoption. By integrating REBA and RULA scores with KAP outcomes and observed exposures, your study adds empirical depth to previous research (e.g. Moyo, Mpofu & Ncube, 2024), offering a comprehensive diagnostic tool for future ergonomic interventions tailored to the realities of underground maintenance work in Zimbabwe.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6. Conclusion and Recommendations

6.1 Conclusion

The study found that DPFs possess good ergonomic safety knowledge and hold positive attitudes, yet demonstrate moderate safety practices due to structural and environmental barriers. REBA and RULA assessments revealed very high ergonomic risk levels, particularly from manual handling, poor lighting, and awkward postures during underground maintenance tasks. Limited access to lifting aids, inconsistent training, and high workload pressure were identified as key constraints preventing safe behavioural application.

Take-home message: Knowledge and attitude alone are insufficient without systemic support ergonomic safety must be enabled through structural investment and consistent training.

Unlike earlier studies, this research uniquely integrates KAP scores with task-specific REBA/RULA observations to build a contextualised understanding of ergonomic exposure in Zimbabwe's underground mining sector.This study provides practitioners with clear insights into the ergonomic realities of DPFs, guiding targeted interventions and policy development to reduce MSD risks. Future research should explore the effectiveness of resource-adapted ergonomic interventions and evaluate institutional safety culture through qualitative inquiry.

6.2 Recommendations

- Enhance access to lifting aids and adjustable workstations to reduce manual handling and postural strain identified in REBA scores.

- Institutionalise regular ergonomic safety training and reporting mechanisms to address observed gaps in formal knowledge reinforcement and low practice compliance.
- Introduce job rotation and rest break policies to mitigate fatigue and musculoskeletal risks linked to repetitive tasks and heavy workload pressures.

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APPENDICES

Appendix 1: Survey Questionnaire

My name is Constance Marange, I am a final-year student at Bindura University of Science Education, studying towards a BSc (Hon) Degree in Safety, Health and Environmental Management (SHEM). I am undertaking research entitled, "Knowledge, Attitudes and Practices of DPFs on ergonomics in a RME." Your views and experiences are significant and will help the study. Participation in this study in completely voluntary and confidential.

Section 1: General information

1. Age Group: ☐ 18–25 ☐ 26–35 ☐ 36–45 ☐ 46+
2. Gender: ☐ Male ☐ Female
3. Job Role:
4. Years of Experience in This Role: ☐ <1 year ☐ 1–5 years ☐ 6–10 years ☐ 11+ years
5. Work Environment: Surface Workshop ☐ Underground Workshop☐

Section 2: Ergonomic safety knowledge

Statement	YES	NOT SURE	NO
I am familiar with the concept of ergonomics in my work setting.			
Poor posture can cause musculoskeletal disorders (MSDs).			
Repetitive tool vibration can lead to ergonomic injuries.			
Heavy manual lifting without aid is an ergonomic hazard.			
Ergonomic design of tools affects my level of strain.			
I have received formal			

ergonomic safety training.			
I know where to report ergonomic hazards in my workplace.			
Rest breaks help reduce MSD risks.			

Section 3: Ergonomic safety attitude

Statement	Agree	Neutral	Disagree
Ergonomic hazards are preventable with correct safety measures.			
Ergonomic tools improve work efficiency and comfort.			
Management supports ergonomic practices consistently.			
Workers should receive regular ergonomic training.			
I feel confident adjusting posture to reduce strain.			
Reporting ergonomic issues is taken seriously at my workplace.			

Section 4: Ergonomic safety practice

Practice	Always	Often	Sometimes	Never
I take scheduled rest breaks to reduce fatigue.				
I use lifting aids or request assistance when handling heavy loads.				
I adjust posture or tool position during repetitive tasks.				

I report ergonomic issues to my supervisor.				
I avoid awkward postures like prolonged bending or overhead work.				

Section 5: Ergonomic exposure and Musculoskeletal risk

Question	**Yes**	**No**
Have you experienced muscle/joint pain in the last 6 months?		
Have you received medical or physiotherapy support for discomfort?		
Do your daily tasks involve repetitive movement?		
Do you regularly use vibrating tools (e.g., grinders)?		
Do you think your work tasks contribute to your discomfort?		

Body areas affected (if any): ☐ Neck ☐ Shoulders ☐ Lower back ☐ Wrists ☐ Knees ☐ Other: ___________

Severity of discomfort: ☐ Mild ☐ Moderate ☐ Severe

Section 6: Challenges to ergonomic practice adoption

Barrier	**Agree**	**Neutral**	**Disagree**
Access to mechanical aids is limited.			
My workload prevents me from applying safe ergonomic techniques.			
Ergonomic training opportunities are			

inadequate.			
Lighting and tool design increase ergonomic exposure.			
There is no clear system for reporting ergonomic issues.			

Section 7: Open Feedback (Optional)

What improvements do you believe would reduce ergonomic hazards at your workplace?

………
……
……
………
…………………………………………

Appendix 2: Ergonomic Observation Checklist

Observer, tick under the appropriate column to record observations

Ergonomic Assessment Checklist	**Activity Assessed**	
Date	**Organization**	
	Personnel Observed :	
	Location	**ROOM/AREA**

Ergonomic Assessment Checklist		
Risk Factors	**Yes**	**No**
Have there been any worker complaints concerning ergonomic issues?		
Have any workshop workers been diagnosed with or reported symptoms of the following Musculoskeletal Disorders (MSDs) : Carpal tunnel syndrome, Tendonitis , Tenosynovitis ,Trigger finger ,White Finger ,Hand-Arm Vibration Syndrome ,Muscle Strains Rotator Cuff Injuries,or Back ailments		
Do employees perform high-repetition tasks? (100 reps/hour to 2000 per/day)		
Do the employee's routine tasks require repeated heavy lifting? (>10kgs) or occasional heavy lifting (>25k)		
Are employees using awkwardly designed tools, which cause the worker to operate the tool outside of a neutral position for an extended period of time?		
Do employees perform tasks with an awkward head or neck position for an extended period of time?		
Do employees perform tasks that require awkward back angles to be held for extended periods of time? (i.e.)…hunching, bending, or squatting		
Do employees perform tasks with an awkward wrist extension angle for an extended period of time (1 to 3 hours) or with extreme force application?		
Do employees perform tasks with an odd work station height (either standing or sitting) for an extended period of time?		
Are high impact tools used routinely? i.e., riveters, bucking bars, or impact wrenches		
Are high vibration producing tools used routinely? i.e., die grinders, sanders, weed eaters		
Do employees perform tasks at an extreme height (high or low) for an extended period of time?		

Are workers using safe lifting techniques, such as bending their knees and keeping loads close?		
Do workers take regular breaks to reduce fatigue and prevent strain?		
Is the required Personal Protective Equipment (PPE) such as gloves, knee pads, and safety gear being used correctly?		
Are workers using mechanical aids or proper lifting techniques for heavy lifting tasks?		
Are available tools and workstations adjusted to compensate for limited ergonomic resources?		
Are cost-effective ergonomic solutions, such as seating adjustments and padding, being implemented?		
Is there sufficient training on behavior-based ergonomic safety practices?		

Appendix 3: REBA and RULA Score sheets

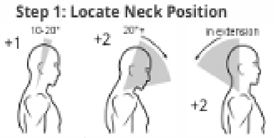
ERGONOMICS PLUS

REBA Employee Assessment Worksheet

Task Name: Date:

A. Neck, Trunk and Leg Analysis

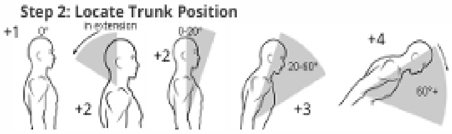
Step 1: Locate Neck Position



Neck Score

Step 1a: Adjust…
If neck is twisted: +1
If neck is side bending: +1

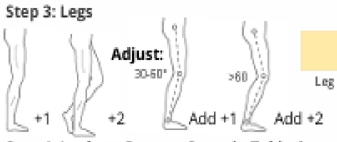
Step 2: Locate Trunk Position



Step 2a: Adjust…
If trunk is twisted: +1
If trunk is side bending: +1

Trunk Score

Step 3: Legs



Leg Score

Step 4: Look-up Posture Score in Table A
Using values from steps 1-3 above,
Locate score in Table A

Posture Score A

Step 5: Add Force/Load Score
If load < 11 lbs. : +0
If load 11 to 22 lbs. : +1
If load > 22 lbs.: +2
Adjust: If shock or rapid build up of force: add +1

Force / Load Score

Step 6: Score A, Find Row in Table C
Add values from steps 4 & 5 to obtain Score A.
Find Row in **Table C**.

Score A

Scoring
1 = Negligible Risk
2-3 = Low Risk. Change may be needed.
4-7 = Medium Risk. Further Investigate. Change Soon.
8-10 = High Risk. Investigate and Implement Change
11+ = Very High Risk. Implement Change

Scores

Table A		Neck											
		1				2				3			
	Legs	1	2	3	4	1	2	3	4	1	2	3	4
Trunk Posture Score	1	1	2	3	4	1	2	3	4	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	6	7	8	9	7	8	9	9

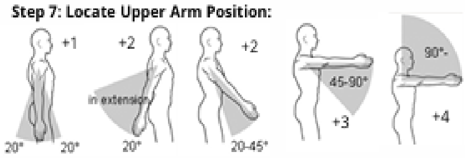
Table B		Lower Arm					
		1			2		
	Wrist	1	2	3	1	2	3
Upper Arm Score	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

Score A	Table C											
	Score B											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	12	12	12
10	10	10	10	11	11	11	11	12	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

Table C Score + Activity Score = REBA Score

B. Arm and Wrist Analysis

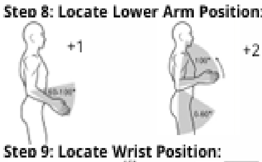
Step 7: Locate Upper Arm Position:



Step 7a: Adjust…
If shoulder is raised: +1
If upper arm is abducted: +1
If arm is supported or person is leaning: -1

Upper Arm Score

Step 8: Locate Lower Arm Position:



Lower Arm Score

Step 9: Locate Wrist Position:

Wrist Score

Step 9a: Adjust…
If wrist is bent from midline or twisted : Add +1

Step 10: Look-up Posture Score in Table B
Using values from steps 7-9 above, locate score in Table B

Posture Score B

Step 11: Add Coupling Score
Well fitting Handle and mid rang power grip, ***good: +0***
Acceptable but not ideal hand hold or coupling acceptable with another body part, ***fair: +1***
Hand hold not acceptable but possible, ***poor: +2***
No handles, awkward, unsafe with any body part, ***Unacceptable: +3***

Coupling Score

Step 12: Score B, Find Column in Table C
Add values from steps 10 &11 to obtain Score B. Find column in **Table C** and match with Score A in row from step 6 to obtain Table C Score.

Score B

Step 13: Activity Score
+1 1 or more body parts are held for longer than 1 minute (static)
+1 Repeated small range actions (more than 4x per minute)
+1 Action causes rapid large range changes in postures or unstable base

Original Worksheet Developed by Dr. Alan Hedge. Based on Technical note: Rapid Entire Body Assessment (REBA), Hignett, McAtamney, Applied Ergonomics 31 (2000) 201-205

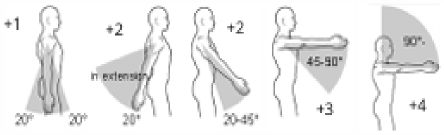
ERGONOMICS PLUS

RULA Employee Assessment Worksheet

Task Name: Date:

A. Arm and Wrist Analysis

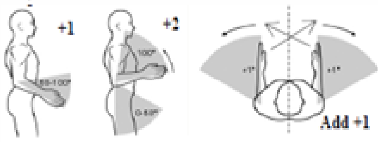
Step 1: Locate Upper Arm Position:



Step 1a: Adjust...
If shoulder is raised: +1
If upper arm is abducted: +1
If arm is supported or person is leaning: -1

Upper Arm Score

Step 2: Locate Lower Arm Position:



Lower Arm Score

Step 2a: Adjust...
If either arm is working across midline or out to side of body: Add +1

Step 3: Locate Wrist Position:

Step 3a: Adjust...
If wrist is bent from midline: Add +1

Step 4: Wrist Twist:
If wrist is twisted in mid-range: +1
If wrist is at or near end of range: +2

Wrist Twist Score

Wrist Score

Step 5: Look-up Posture Score in Table A:
Using values from steps 1-4 above, locate score in Table A

Posture Score A

+

Step 6: Add Muscle Use Score
If posture mainly static (i.e. held>10 minutes),
Or if action repeated occurs 4X per minute: +1

Muscle Use Score

+

Step 7: Add Force/Load Score
If load < .4.4 lbs. (intermittent): +0
If load 4.4 to 22 lbs. (intermittent): +1
If load 4.4 to 22 lbs. (static or repeated): +2
If more than 22 lbs. or repeated or shocks: +3

Force / Load Score

=

Step 8: Find Row in Table C
Add values from steps 5-7 to obtain Wrist and Arm Score. Find row in **Table C**.

Wrist & Arm Score

Scores

Table A		Wrist Score 1		Wrist Score 2		Wrist Score 3		Wrist Score 4	
Upper Arm	Lower Arm	Wrist Twist 1	Wrist Twist 2	Wrist Twist 1	Wrist Twist 2	Wrist Twist 1	Wrist Twist 2	Wrist Twist 1	Wrist Twist 2
1	1	1	2	2	2	2	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	3	3	3	3	4	4
2	1	2	3	3	3	3	4	4	4
	2	3	3	3	3	3	4	4	4
	3	3	4	4	4	4	4	5	5
3	1	3	3	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	4	4	4	4	4	5	5	5
4	1	4	4	4	4	4	5	5	5
	2	4	4	4	4	4	5	5	5
	3	4	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	8	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

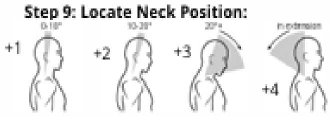
Table C		Neck, Trunk, Leg Score 1	2	3	4	5	6	7+
Wrist / Arm Score	1	1	2	3	3	4	5	5
	2	2	2	3	4	4	5	5
	3	3	3	3	4	4	5	6
	4	3	3	3	4	5	6	6
	5	4	4	4	5	6	7	7
	6	4	4	5	6	6	7	7
	7	5	5	6	6	7	7	7
	8+	5	5	6	7	7	7	7

Scoring: (final score from Table C)
1-2 = acceptable posture
3-4 = further investigation, change may be needed
5-6 = further investigation, change soon
7 = investigate and implement change

RULA Score

B. Neck, Trunk and Leg Analysis

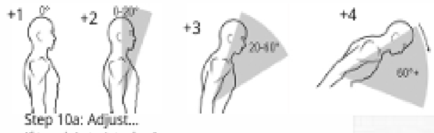
Step 9: Locate Neck Position:



Neck Score

Step 9a: Adjust...
If neck is twisted: +1
If neck is side bending: +1

Step 10: Locate Trunk Position:



Step 10a: Adjust...
If trunk is twisted: +1
If trunk is side bending: +1

Trunk Score

Step 11: Legs:
If legs and feet are supported: +1
If not: +2

Leg Score

Neck Posture Score	Table B: Trunk Posture Score 1 Legs 1	1 Legs 2	2 Legs 1	2 Legs 2	3 Legs 1	3 Legs 2	4 Legs 1	4 Legs 2	5 Legs 1	5 Legs 2	6 Legs 1	6 Legs 2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	5	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	7	8	8
5	7	7	7	7	7	8	8	8	8	8	8	8
6	8	8	8	8	8	8	8	9	9	9	9	9

Step 12: Look-up Posture Score in Table B:
Using values from steps 9-11 above, locate score in Table B

Posture B Score

+

Step 13: Add Muscle Use Score
If posture mainly static (i.e. held>10 minutes),
Or if action repeated occurs 4X per minute: +1

Muscle Use Score

+

Step 14: Add Force/Load Score
If load < .4.4 lbs. (intermittent): +0
If load 4.4 to 22 lbs. (intermittent): +1
If load 4.4 to 22 lbs. (static or repeated): +2
If more than 22 lbs. or repeated or shocks: +3

Force / Load Score

=

Step 15: Find Column in Table C
Add values from steps 12-14 to obtain Neck, Trunk and Leg Score. Find Column in **Table C**.

Neck, Trunk, Leg Score

Original Worksheet Developed by Dr. Alan Hedge. Based on RULA: a survey method for the investigation of work-related upper limb disorders, McAtamney & Corlett, Applied Ergonomics 1993, 24(2), 91-99

Appendix 4: Ethical clearance and Consent documents

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE
DEPARTMENT OF ENVIRONMENTAL SCIENCE

Bindura University of Science Education

P. Bag 1020
Bindura, Zimbabwe
Tel: 263 - 71 – 6505
Cell : 0778371588
Email : tnyamugure@buse.ac.zw

BINDURA UNIVERSITY OF SCIENCE EDUCATION

24 October 2024

Dear Sir/Madam

REQUEST FOR PERMISSION TO COLLECT DATA FOR ACADEMIC RESEARCH PROJECT

This letter serves to inform you that **Constance Marange (B211686B)** is a fourth year student at Bindura University of Science Education, in the Department of Environmental Science. During her fourth year of study she is supposed to do a research project in her area of specialisation.

Please assist in any possible way. Data collected will be used for academic purposes only and will not be published without your prior consent.

Thank you for your assistance.

Yours faithfully.

Mr .T .Nyamugure
Chairperson - Department of Environmental Science

SANDVIK

SHE Manager

SANDVIK

29/05/25

Dear Constance Marange (B211686B),

Re: Permission to Collect Data for Research entitled," Knowledge, Attitudes and Practices of Diesel plant fitters on Ergonomics in a Resource-Constrained Mining Environment."

This letter serves to grant you permission to collect data as part of your research project for your university studies. We appreciate your interest in understanding the knowledge, attitudes, and practices of our diesel plant fitters regarding ergonomics in a mining environment. We believe that your research will contribute valuable insights into improving occupational health and safety practices within our organization. Our team is willing to participate and provide necessary information to support your data collection.

Please ensure that:

1. All data collection activities are conducted during working hours and do not disrupt normal operations.

2. Confidentiality and anonymity of our employees and company information are maintained.

3. You adhere to our site-specific safety protocols and regulations.

If you require any further assistance or clarification, please do not hesitate to contact me.

Kind Regards,

R.Chinemhute

SHE Manager

Appendix 5: Statistical outputs

Purpose: This appendix presents raw and formatted output from SPSS or equivalent statistical software used to analyse data from the questionnaire and ergonomic assessments.

A. KAP Scores Analysis – Descriptive Statistics

Variable	Mean	SD	Min	Max
Knowledge Score	8.25	1.43	5	10
Attitude Score	6.70	1.82	3	9
Practice Score	5.85	2.11	2	9

(Source: SPSS Descriptive Output – KAP Composite Variables)

B. Inferential Analysis – t-test Output

Objective: Compare mean knowledge scores by work environment (Surface vs underground)

Group	Mean	SD	N
Surface Workers	7.92	1.31	12
Underground Workers	8.45	1.48	23

- $t(33) = -1.12$, $p = 0.27$ → No statistically significant difference

C. ANOVA – Practices vs Work experience

Groups: <5 years, 6–10 years, 11+ years $F(2,32) = 2.83$, $p = 0.07$ → Marginal variation in ergonomic practices based on experience level

D. Correlation – REBA vs Practice scores

Pearson's $r = -0.41$, $p < 0.05$ → Moderate negative relationship between REBA scores and reported safe practices — higher physical strain relates to lower compliance

Appendix 6: Images

Image 1: DPF engaged in manual component handling. Task performed in ergonomically compromised postures with minimal mechanical support and poor illumination.

Image 2: DPF conducting industrial equipment maintenance under poor lighting and confined conditions. Elevated postural and manual strain observed during underground task execution.