BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

DEPARTMENT OF ENVIRONMENTAL SCIENCE

ASSESSMENT OF ERGONOMIC RISKS USING RAPID ENTIRE BODY ASSESSMENT (REBA) AND RAPID UPPER LIMB ASSESSMENT (RULA) AMONG WOODCUTTERS. CASE STUDY OF BOARDEX MSASA ZIMBABWE.

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B200658B

A Dissertation Submitted in Partial Fulfilment of the Requirements of the Bachelor of Science Honours Degree in Safety, Health and Environmental Management

SUBMITTED

JUNE 2024

DEDICATION

I dedicate this dissertation to my family, whose unwavering love and support have been my source of strength throughout this journey. Your encouragement and belief in me have been instrumental in my success.

ACKNOWLEDGEMENTS

First and foremost, I humbly acknowledge the divine presence of God in my life, whose grace and guidance has been my constant companions on this academic journey. I offer my deepest gratitude to the Almighty for His unwavering support.

I also express my heartfelt appreciation to my dissertation supervisor P Nhokovedzo, for his support and guidance throughout this research endeavour.

To my parents Mr and Mrs MUZADZI, my brother Prosper and my friends Mitchelle and Mr Architect this is for you. Your love knows no bounds, and would like to I extend my heartfelt thanks for standing by me through thick and thin. Your belief in my abilities has been the cornerstone of my success, and I am forever indebted to you for your unwavering support.

Lastly, I would like to extend my heartfelt gratitude to the BoardEx woodcutters who participated in this study. Their willingness to share their experiences and insights has made this research possible.

ABSTRACT

Background: Woodcutting is a physically demanding occupation that exposes workers to various ergonomic risks, leading to musculoskeletal disorders (MSDs) and injuries. Ergonomic risks include awkward postures, vibrations, force exertions, and repetitive movements. The purpose of this study was to assess ergonomic risk, among woodcutters using Rapid Entire Body Assessment (REBA) and Rapid Upper Limb Assessment (RULA) tools. Furthermore, contributing factors to ergonomic risks, most affected body parts, and posture analysis among woodcutters were also assessed. **Methodology:** A descriptive cross-sectional study were assumed with N=26 woodcutters from BoardEx, Zimbabwe. Data was gathered using a structured Nordic Questionnaire, RULA score sheet, and REBA score sheet (Appendix 1, Appendix 2, and Appendix 3 respectively). Direct observational data was collected on body postures, forces and durations for common woodcutting tasks. **Results:** REBA and RULA mean scores were determined for different body postures and most affected body parts. Regression analysis explored relationships between REBA, RULA scores and ergonomic risk factors. Chi squared test was used to assess the level of association between ergonomic risk and contributing factors (age and prolonged working hours) hence, an association was achieved. Key results showed moderate-high risks for the back, neck, arms and wrists, with average scores of 5-7. Postural risks like bending, manual lifting, and repetition were identified. **Conclusions:** The findings of this research conclude that BoardEx woodcutters face wide range of ergonomic risk as observed without them knowing risk associated with their job tasks. The present research demonstrated that both work exposures (prolonged working hours) and individual factor (age) have an essential impact on the like hood of developing MSDs. The majority of woodcutters suffer from back pain injuries.

Keywords: REBA, RULA, Ergonomics, MSDs

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LIST OF ACRONYMS AND ABBREVIATIONS

WRMSDs	Work Related Musculoskeletal Disorders
REBA	Rapid Entire Body Assessments
RULA	Rapid Upper Limb Assessments
MSDs	Musculoskeletal disorders
WBV	Whole Body Vibrations

CHAPTER ONE: INTRODUCTION

1.1BACKGROUND OF STUDY

Forestry work is generally characterized as heavy, dirty and dangerous work requiring unnatural and uncomfortable working postures and exposures to noise and vibration (Lewark, 2015; Potocnik and Poje, 2016; Jerie and Jenya, 2017). In general, forestry continues to be among one of the most hazardous sectors globally due to multifaceted aspects of its outdoor work (Jerie, 2012; Cabecas, 2017). The global forestry industry has seen an increasing focus on the health and safety of workers, including addressing ergonomic risks associated with manual handling (Smith et al., 2017). The use of chainsaws and other handheld tools in forestry work presents ergonomic challenges that can lead to musculoskeletal disorders (MSDs) among workers (European Agency for Safety and Health at Work, 2019). In the reported statistics, workforce alone stands at 2, 8 billion with approximately 300 000 employed in the forestry industry and globally 2, 2 million work-related fatalities and 270 million occupational injuries occur annually (Cremasco et al., 2019; Knecht et al., 2023). The largest number of fatalities is associated with the timber industry with 92, 4 % deaths (Knecht et al., 2023). Available statistical data have indicate that accident rate in forestry operation is significantly higher per employee compared to other high risk economic sectors in developed countries (Yaylı, 2019). For example, fatalities in Germany were reported to be 3 times higher in the forestry sector compared to construction and twice with regards to agriculture (Landekić et al., 2019). In Spain, the incident rate of all other sectors was 3 to 4 times lower compared to that of forestry (Hanewinkel et al., 2022). In United State, fatal accident rate in forestry was 19 times higher than other sectors, 11.5 times greater in the New Zealand forest sector, with loggers being the most exposed (Phairah et al., 2021). In Australian forestry sector, injuries were 2 to more than 3 times greater than in the rest of industries (Pecyna, 2021).

In Africa, the forestry industry faces similar ergonomic risks, particularly in countries like Zimbabwe, where manual labour is prevalent in timber harvesting and processing activities (Moyo et al., 2018). In Nigeria, forestry work related injuries and fatalities constituted 25% of the total accidents (McCann and Babin, 2020). In South Africa, approximately 20% of traumatic occupational accidents are from wood processing (Knecht et al., 2023).

Zimbabwe forestry workers are not an exception to the occupational safety and health problems facing forestry workers worldwide (Jerie and Jenya, 2017). Occupational accidents and related diseases have been a serious challenge for Zimbabwe in the past twenty years of economic and infrastructural de-capitalization (Matsa and Mandowa, 2015). This has seriously affected the forestry sector with the average injury frequency rate for the forestry sector noted as four for the past years thereby placing the forestry sector among the top ten unsafe and unhealthy occupations in Zimbabwe (Mutetwa and Dozva, 2013). The prevalence of MSDs among forestry workers has been a growing concern, impacting productivity and worker well-being. Limited access to ergonomic training and awareness programs further exacerbates these risks in the Zimbabwean forestry industry (Chikasha et al., 2021). According to Jerie and Jenya (2017), occupational fatalities involving forest workers in Zimbabwe have been occurring every year with an average of two fatalities per year. Although agriculture has become mechanized, forestry operations in Zimbabwe are still characterized by activities done manually. In a study by Jerie (2012) there could be more serious health impacts associated with forestry activities in Zimbabwe. Extensive research has not been done on specific health impacts. It however appears that there are few systematic studies in open literature that seeks to understand this high prevalence of ergonomic injuries in forestry operations in Zimbabwe. Therefore, this work seeks to contribute to the understanding of the factors that contribute to ergonomic risks in the Zimbabwean context. The research is in the form of a case study of wood processing company in Zimbabwe called BoardEx.

BoardEx is a wood processing company in Zimbabwe and has not been spared from work related ergonomic incidents. Among all other occupations at BoardEx woodcutters is the most exposed group to ergonomic risk. It is clear from BoardEx's extensive research database that woodcutters face a unique combination of ergonomic risk due to manual handling, forceful exertions, repetitive motions and straining postures. Further, the safety culture at BoardEx is still at incipient stage and not every employee takes safety seriously, some are not watchful, some are complacent, and compromise too readily. Therefore it is against this background that it seeks to assess ergonomic risks using REBA and RULA among woodcutters at BoardEx.

1.2 PROBLEM OF STATEMENT

The woodcutting industry is inherently laden with ergonomic risks posing potential threats to the health and safety of workers. Despite the prevalence of these risks, there is a noticeable gap in research focusing on specific ergonomic challenges faced by woodcutters in Harare, Zimbabwe, particularly at BoardEx. The absence of a targeted assessment using established methods like Rapid Entire Body Assessment (REBA)and Rapid Under Limb Assessment (RULA) further exacerbates the situation, leaving woodcutters vulnerable to Musculoskeletal disorders (MSDs) and other occupational health issues. This research seeks to address these gaps by conducting a detailed examination of ergonomic risk among woodcutters at BoardEx aiming to provide valuable insights, recommendations and interventions, promoting safety culture and a safe working environment.

1.3 JUSTIFICATION OF THE STUDY

The study is crucial because of its potential to enhance the safety and wellbeing of woodcutters at BoardEx in Harare, Zimbabwe through pinpointing ergonomic risks and propose interventions to enhance the working conditions and safety of woodcutters. Further the adopted research methodology and results thereof can act as a benchmark for related research. This is especially important for the forestry industry in Zimbabwe where systematic studies of this nature are scarce. Cooperate world can also benefit from this work as it establish whether REBA and RULA are good tools to assess and improve body postures and movement of woodcutters in forestry industry. The outcome of this research can also be used by government and regulatory bodies including the, Ministry of Public Service Labour and Social Welfare; Ministry of Lands, Agriculture, Fisheries, Water and Rural Development; Ministry of Health and Child Care; and Ministry of Industry and Commerce in policy and framework formulation regarding management of work related ergonomic issues among forestry production companies. The National Social Security Authority (NSSA) can also benefit from the outcome of this research through the adoption of REBA and RULA for a systematic and objective means to evaluate the ergonomic hazards associated with wood cutters.

1.4 RESEARCH OBJECTIVES

To assess ergonomic risks using REBA and RULA among woodcutters at BoardEx and establishing a strong safety culture.

1.4.1 SPECIFIC OBJECTIVES

To identify specific ergonomic risks faced by woodcutters at BoardEx.

To assess body postures and body parts affected using REBA and RULA at BoardEx.

1.5 RESEARCH QUESTIONS

What are the predominant ergonomic risks encountered by woodcutters?

What is the relationship between contributing factors and ergonomic risks?

Which body parts are mostly affected by given postures and can REBA and RULA help to identify those?

CHAPTER TWO: LITERATURE REVIEW

2.1 OVERVIEW

In many countries around the world there has emerged discouraging trends such as a rise in rates of work-related accidents which, combined with a rise in occupational diseases, are responsible for the high rate of early retirement in the forest industry (Gallo et al., 2017). Industries operate with a primary motive of increasing profits attained though production improvements, that can be either by increasing number of shifts and thus output or by investing more in automation (Carrillo-Castrillo, 2016). Production and profit maximization are the main motives; however, during the production process there is an increasing interaction between human beings and machinery (Prissanis et al., 2010). There are many aspects created by carrying out each task, meaning, employees are exposed to various occupational risks and health problems. McPhee (2005) argues that in order to understand ergonomics fully there are five elements that must be considered. These are the worker, job/ task design, work environment, equipment design and the work organization.

Equipment design is the hardware of the workplace. It is the essential part of ergonomics that everybody recognizes and it includes electronic and mobile equipment, protective clothing, furniture and tools (Kolstrupt, 2012). Work organization is the broader context of the organization and the work and how it affects individuals. It is inclusive of patterns of work, peaks and troughs in work load, shift work, rest and work breaks, teamwork and also the workplace culture (Kim, 2015).

Factors that contribute to occupational risk in forestry include having little opportunity to influence the work (Mulhollem, 2021), a poor psycho-social environment (Haeberle, 2020), little recognition for work performed (Krajnak, 2018), low self-esteem (Lagerstrom et al., 2019), lack of experience of the work (Kim, 2017), smoking (Newmanetal., 2018), poor physical fitness and a previous history of muscular and joint disorders (Rodriguez et al., 2019). A closer inspection of the accidents occurring in the forestry industry reveals that harvesting is far more hazardous than other forestry operation (Wilmsen et al., 2019).

2.2 THEORETICAL REVIEW OF ERGONOMICS

2.2.1 ERGONOMICS

Ergonomics can be defined as the science of designing the job to fit the worker, rather than physically forcing the worker’s body to fit the job (Bridger, 2009). Ergonomics draws on a number of scientific disciplines, including physiology, biomechanics, psychology, anthropometry, industrial hygiene, and kinesiology (Mccauley Bush et al., 2012; Manz & Silver, 2013; Shirzaei et al., 2015). Ergonomics plays a major role with ensuring that work is designed to take account of the people, their capabilities and the limitations, however, ergonomics is alluded to be the cause of work-related musculoskeletal disorders (Jaffar et al., 2011). The ergonomics approach focuses on the appropriate design of workplaces, systems, equipment, work processes, and the environments to accommodate the workers (Luiza et al., 2012; White, 2013; Ayu Bidiawati et al., 2015; Ncube et al., 2018). Ergonomics is concerned with ensuring that work is designed to take account of people, their capabilities and limitations (Scott et al., 2020). Capabilities between the human operator and the entire work system can be achieved at a biomechanical, anatomical, physiological, behavioural and cognitive level (Dempsey et al., 2018). The ergonomic approach focuses on the appropriate design of workplaces, systems, equipment, work processes and environments to accommodate the workers (Yovi and Yamada, 2019). There has been limited ergonomics research in the forestry industry in Africa particularly Zimbabwe (Jerie and Jenya, 2017,).

Ergonomics is important because it enhances worker's performance and it also prevents workers from work related injuries. It is directed towards to fit workers with their work task and jobs, equipment, environment and work systems to ensure that the workplaces are efficient, safe, and comfortable. The major importance of ergonomics is that it improves the workplace environment so that it best suits the workers and enables efficiency and quality production. It is important for the work design, work task, the environment to suit the capabilities and needs of the worker.

2.2.2 BIOMECHANICAL MODEL

Biomechanical assessment techniques are applicable for both static and dynamic assessment of physical risk factors; these use the concept of inverse dynamics to determine the forces, torques, and stresses at joints and segments and also solve force distribution problems in muscles at each joint or body segment. Biomechanical assessments are based on the knowledge that joints stabilize the segments and sustain external loads by engaging muscles and generating torques. Thus, analysing the stresses on individual joints will be beneficial in determining joint strength and energy loss during a continuous working process (Ma et al. 2019). Ayoub and Wolstad (2019) identified the need for an understanding of the cumulative effects of work tasks performed over days, years, and even an entire working career, as this would help prevent WRMSDs. In this regard, the development of models capable of considering dynamic components of lifting tasks, possible antagonistic muscle forces, passive tissue loading, and three dimensional loading characteristics of the muscles would be more realistic (Waters et al.

2019). As part of this study, a body segment-based biomechanical model was used and adaptable for assessing the moments and stresses resulting from residential woodcutting work.

2.2.3 DIGITAL HUMAN MODEL

Digital human modeling provides visualization information about various postural and material handling operations. These digital models integrate traditional posture analysis techniques such as RULA, REBA and biomechanical assessment techniques into the visualization tools in order to simulate the work scenario. This technology allows ergonomists and engineers to perform virtual builds, and the rapid adoption of virtual tools presents an opportunity to integrate considerations of ergonomics into the early design stages (Mathiassen et al. 2020). The tools are applied in the design, modification, visualization, and analysis of human workplace layouts and product interactions.

2.2.4 ARTIFICIAL INTELLIGENCE MODEL

Computer-based models also include models which use Artificial Intelligence Methods as quantitative frameworks. These include specialized ergonomic analysis models based on expert/cognitive models, and methods such as fuzzy-based systems. A Fuzzy-based system captures and adapts industry experts' knowledge and experience for workplace safety risk evaluations. The fuzzy set theory was applied to develop and model the ergonomic workload stress index (Chen et al. 1994) to predict the existence and level of ergonomic workload stress. The main challenges associated with this method are the task of fitting fuzzy connective and logical operators to human judgmental data in the design and evaluation, as well as the vagueness of natural language. The application of fuzzy technology to ergonomics and for modelling injury risk has thus been limited (Leondes 2019).

2.3 ERGONOMIC RISKS ASSOCIATED WITH WOODCUTTING

2.3.1 AWKWARD POSTURE

Scott et al (2015) define an awkward working posture as a posture or working action required to execute a task that creates some discomfort, or cannot be maintained by the worker. An awkward posture is adopted when a body part is used well beyond its neutral position (HSE, 2018). A neutral position is where the trunk and head are upright, the arms are by the side of the body, the forearms are hanging straight or at right angles to the upper arm, and the hand is in the handshake position (HSE, 2018). Posture refers to the position of your body's various parts. Muscles, tendons and ligaments have to work harder and can be stressed in an awkward position (Kolgiri et al, 2016). In a case study that conducted manufacturing process automation in Korea, it has been stated that the number of cases of MSSs is increasing frequently each year. One of the factors related to MSs was awkward postures by workers/operators especially in the assembly part section. Operators who work in uncomfortable positions can increase the risk of low back pain (O'Sullivan, 2012). O'Sullivan (2012) also mentioned that prolonged sitting periods, for example periods exceeding 30 minutes, are a common aggravating factor for many subjects with low back pain. Examples of awkward postures experienced by woodcutters include bending, standing, twisting, squatting, and kneeling.

2.3.2 REPETITIVE MOTION

Repetition rate is defined as the usual number of movements or actions done in a given unit of time by a joint or body link or executing similar actions with the same part of the body with little break or recovery (Jaffar et al, 2011). Repetition places employees at an augmented jeopardy of damage when other risk factors, such as an awkward posture or heavy force, are also present (Kolgiri et al, 2016). Conferring to study findings, due to standardized workstations, high frequency of musculoskeletal signs and associated physical complications in the production firms was highly repetitive (Kolgiri et al, 2016). In some of the earliest studies reported in the ergonomics literature on sewing machine operators, operators reported pain in the past 12 months in at least one region of the body and most often in the lower back, neck and wrist / hand and neck, shoulders and lower limbs (Van et al, 2016).

2.3.3 VIBRATION

Vibration can cause problems such as harm to body organs instigated by extreme levels of tremor at moderately low frequencies and failure of body tissues as a result of either nonstop resonance or high energy tremor absorption (Jaffar et al, 2011). Whole Body Vibration (WBV) happens when vibrations are frequently spread through the feet when a person is standing or when sitting on the legs and hips. WBV, including internal tissues, can affect the entire body. The entire body's contact to shaking has been viewed by many schools of thought as a risk of injury (Jaffar et al, 2011). Van et al, (2016) and (Kittusamy, et al, 2004) both agree to it that workroom tremor exposure and work-related stress are a noteworthy hazardous factor for neck, shoulder, lower spine and upper back discomfort or pain. Other than that, in an investigation among workers of construction equipment that was carried out by (Kittusamy and Buchholz, 2004) analysed that whole-body vibration (WBV) and the postural necessities of work (both static and awkward postures) are imperative risk issues that underwrite the growth of musculoskeletal disorders between industrial workers. Choobeneh et al, (2016) also agree to the findings by highlighting that vibration is among the very significant risk factors affecting workers in manufacturing industries.

2.3.4 FORCE EXERTION

Force is the amount of effort our bodies have to make in lifting objects, using tools, or moving. Since, as a rule, there is not enough time for recovery in repetitive work, the more powerful movements develop tiredness much faster (Kolgiri et al, 2016). According to Department of Environmental Health and Safety (IOWA State University, 2013), forceful movements refers to the amount of effort needed to perform a task or motion. Younger people have been reported to have a higher predisposition to develop low back MSs, as it is more common for younger people to carry out activities that require strong movements and postures, making them more susceptible to low back MSSs (Costa and Vieira, 2010). In contrast, older individuals may perform activities that do not require as much physical effort; they are more likely to perform activities' that demand more precise upper limb tasks instead, such as computer-related activities and line assembly tasks.

2.4 CONTRIBUTING FACTORS TO ERGONOMIC RISKS

2.4.1 ORGANIZATIONAL FACTORS

Ergonomics issues are excluded in existing legal instruments (Ncube & Kanda, 2018) and most sectors of the economy lack access to proper ergonomic know how (France, Artwell, & Tatenda, 2018; Moyo et al., 2015; Ncube & Kanda, 2018). The lack of ergonomists and knowledge of WMSDs contribute to the organisational practices that may prompt high risk for example lack of appropriate work equipment and working in unsafe conditions.

2.4.2 AGE

Age, independent of many other considerations, has been demonstrated to alter humans' power to work. People's mental and physical well-being deteriorate as they age, resulting in a mismatch between occupational needs and individuals' work capabilities. Luttmann et al. (2016): This mismatch could have serious implications, including higher chances for impairment, occupational injury, ergonomic problems, and poor performance. Peytremann-Bridevaux, I., (2016) Aging is associated with a decline in mental and physical well-being. In this line, there is a significant decline in muscle endurance, bone strength, and aerobic capacity, which causes a sharp decline in functional capacity, particularly at the age of 60 and beyond, depending on an individual's lifestyle, body weight, and heredity (Garg et al., 2014)

2.5 RULA AND REBA RISK ASSESSMENT TOOLS

RULA (Rapid Upper Limb Assessment) and REBA (Rapid Entire Body Assessment) are methods for occupational postural risk assessment (Lasota, 2019). Indeed, previous studies (Kong et al., 2018; Poto et al., 2017) showed that observational methods are considered effective in the assessment of biomechanical work-related overload, having the advantage of being more versatile and less expensive in terms of time and resources required compared to objective laboratory measures. Both RULA and REBA allow to obtain a numerical index that represents the quantitative value of the risk the worker is exposed to during the targeted work activity and to derive the priority level of intervention and the actions needed (Kong et al,., 2018). The RULA method is suggested for the identification of postural disorders of the upper limbs, of the neck and of the back in relation to the muscular action and external loads applied to the body (Mokhtar et al., 2020). The REBA technique (Hignett and McAtamney, 2000) method is applied to identify postural disorders of the whole body, legs, neck, shoulders, arms and wrist in relation to the muscular action, to the external loads applied to the body and to the type of grip (Upasana and Vinay, 2017). They are referenced in the international standard for occupational risk assessment and cited among the selected tools for Work-related Musculoskeletal Disorders (WMSDs) prevention according to International Ergonomics Association (IEA) and World Health Organization (WHO). These methods are also widely applied in several working contexts, mainly industrial work activities (secondary sector) and those producing services and goods (tertiary sector), characterized by a precise standardization of tasks, geometries, gestures and relative execution frequencies that allow a systematic and controlled forecasting and quantification of the biomechanical overload risk (Wilmsen et al., 2019).

Furthermore, the two methods have been combined and compared to assess postural risk in industry (Wempe et al., 2019), construction (McCann, 2020), supermarkets (Yaylı, 2019), hospital and dental sector (Knecht, 2020), work with video terminals (Krajnak, 2018), waste collection activities (Lagerstrom et al., 2019), for fire-fighters and emergency medical technicians (Kim et al., 2017), and artisans (Krajnak, 2018) and sawmill activities (Rodriguez et al., 2019).

2.6 RESEARCH GAP

Various studies on safety related issues in the forestry industry have been done worldwide (Jerie, 2012; Gallo et al., 2017; Okon et al., 2019; Yaylı, 2019; Mulhollem, 2021; Roome et al., 2022). However, most of these studies were mainly focused on accidents and injuries associated with forestry industry activities. Researchers such as (Poto and Poje, 2017; Lynch et al., 2019; Ojha and Kwatra, 2020; Lundstrom et al., 2022), have managed to dig-into ergonomic related issues in the forestry sector, however these studies mainly focused on developed countries such as Germany, Australia, Spain, and United States. Few studies (Gallo et al., 2017; Yovi and Yamada, 2019; Phairah, 2020) have managed to tackle ergonomic issues in developing countries' forestry industries such as South Africa, Ghana, Angola and Zimbabwe however, these studies were generic in nature. Moreover, these studies failed to incorporate ergonomic assessment techniques such as REBA and RULA particularly in Zimbabwe. Studies which used ergonomic assessment techniques such as REBA, RULA and OWAS where mainly focused on construction industry (Hanewinkel et al., 2021), waste collection activity (Landekić et al., 2017), fire-fighters and emergency medical technicians (Lewark et al., 2015) leaving forestry industry particularly woodcutters. Therefore this research seeks to address these gaps by conducting a detailed examination of ergonomic hazards among woodcutters using REBA and RULA at BoardEx, Zimbabwe.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Description of the Study area

The study was conducted at BoardEx which is situated in Harare district under Harare province of Zimbabwe (Latitudes 31° 6’0” and 31° 12’0” N and Longitudes 17° 40’0” and 17° 48’0” E) see (Figure 1). BoardEx Zimbabwe (Pvt) Ltd is strategically located in a fast growing and popular Msasa light industry area found in the east of Harare, close to Mutare Harare highway. BoardEx Company currently employs approximately 35 woodcutters.

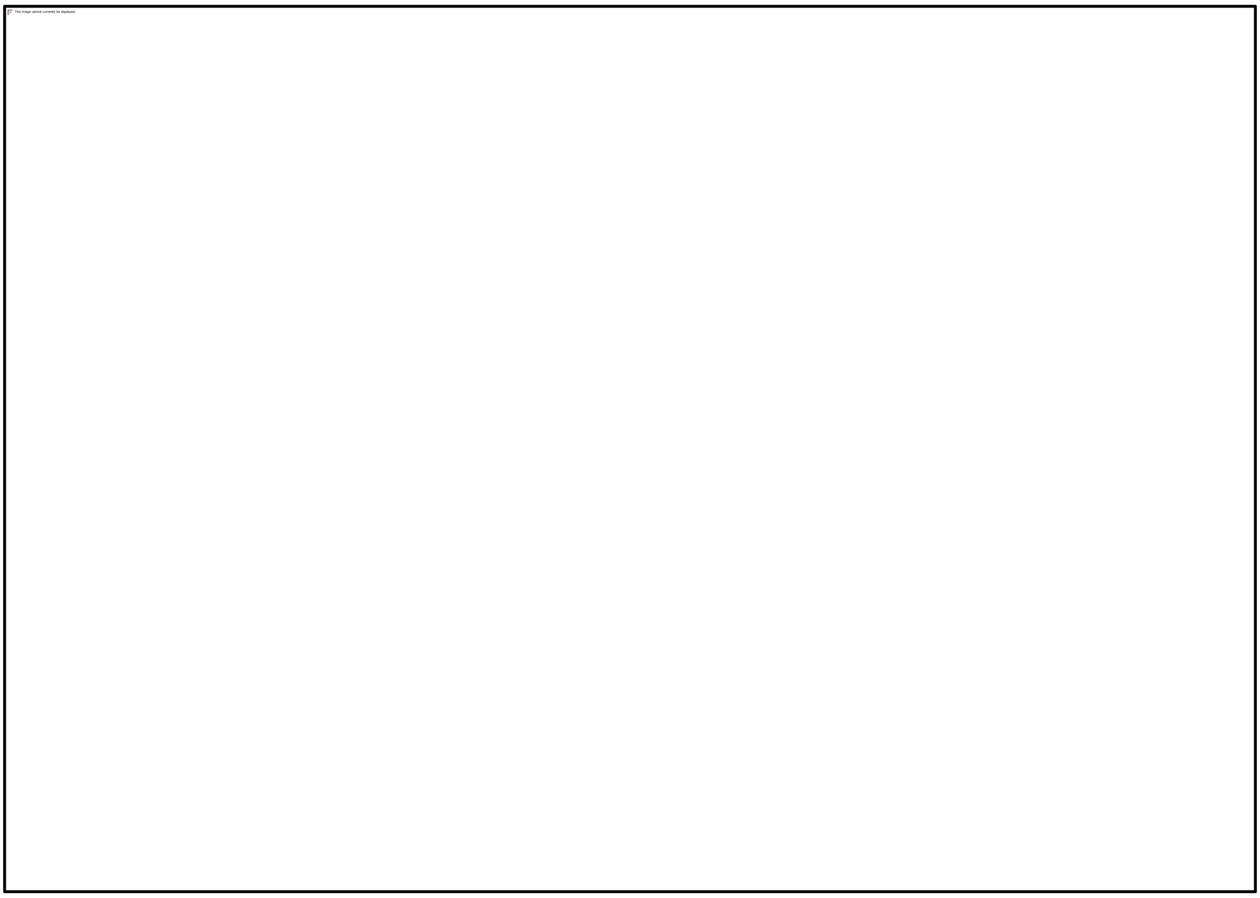

Figure 3.1 BoardEx Study Map

3.2 RESEARCH DESIGN

This study used a descriptive cross sectional study design on woodcutters at BoardEx which is non-experimental research design with a walk-through survey and result analysis. A cross sectional study involves collection of data from specific populations at a particular point in time (Wang and Cheng, 2020). Observational studies are valid, reliable, and low cost, and ease of use means they can be used to assess working postures without interfering with work. These methods are therefore more widely used in industry (Kee and Karwowski, 2017; David, 2015). With cross sectional study design, the researcher managed to assess the prevalence of ergonomic risk using REBA and RULA among woodcutters at BoardEx. The researcher gathered data using a structured NORDIC questionnaire with close ended and open ended for both qualitative and quantitative data. The study applied a mixed methods approach. According to Tashakkori and Teddlie, (2013) mixed methods play a vital role in assessing ergonomic risk hence; it allows triangulation of data from multiple sources, a comprehensive data collection, and validation of findings and improved understanding of ergonomic hazards.

3.3 TARGET POPULATION

BoardEx was selected as a sample unit and the target population comprised of woodcutters. A total of 35 woodcutters were targeted by this study. The woodcutters were targeted because of the nature of their activities that expose them to ergonomic risk factors.

3.4 SAMPLING PROCEDURE

Purposive sampling was used to select key informants such as woodcut. This type of sampling method enabled the quick gathering of data by specifically targeting certified individuals from organizations that are valuable to the study.

To calculate the sample size of this research, the following formula was employed.

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

Where n is sample size, e is sampling error, N is number of woodcutters at BoardEx

Given: N= 35, e = 0.10

Thus: n = 35/ (1+35(0.10)2)

n = 26 woodcutters at BoardEx

26 woodcutters at BoardEx was the sample size for the study. Random sampling was used to select 26 woodcutters at BoardEx to participate in questionnaire survey. Numbers were assigned to woodcutters at BoardEx and then were selected randomly. Random sampling was

chosen hence, it reduces bias in selection since every participant had equal opportunity of being selected.

3.5 DATA COLLECTION METHODS

In the study Nordic Standardized Questionnaire was used in this research. REBA and RULA were used to evaluate body postures and body parts affected while performing different task.

3.5.1 NORDIC QUESTIONNAIRE

The Nordic questionnaires were administered physically to the selected 26 woodcutters at BoardEx. In order to obtain accurate information about the research objectives, the researcher used a questionnaire guide characterized with open-ended and closed-ended questions to gather qualitative and quantitative data. Open-ended questions require respondents to express their true feelings about the question at hand without any limitations. Closed ended questionnaires required respondents to provide a specific answer by ticking yes or no, and this provided researchers with basic information about the study. The Questionnaire guide was divided into three sections. Section A, showing demographic information of participants such as age, marital status, and educational level. Section B had questions aimed to identify the contributing factors for ergonomic hazards. Lastly section C consisted of a body map highlighting nine symptom sites that is the neck, shoulder, upper limbs, elbows, low back, forearm, thighs, knees, and ankles.

3.5.2 REBA

REBA method (Hignett and McAtamney, 2000) is a semi quantitative body evaluation that considers the static muscles, movement angulations, load handling, work repetitiveness, and handle quality. Posture scores were obtained with angulation specific tables to body group segments: A (trunk, neck, and legs) and B (arms, forearms, and wrists). The scores for the neck, trunk, and legs were used to come up with Group (A) score from table An on REBA score sheet. The scores for lower arm, wrist, and upper arm were used to determine the group B score from table B on the REBA worksheet. Group A score was combine with load and force scores to make score A. Group B score was combined with coupling score to come up with score B. Table C was used to determine a combined score C. Score C was added with muscle activity score to come up with final REBA score as illustrated in the REBA worksheet at the appendix.

Finding score:

1 indicates negligible danger

2 or 3 = minimal risk, alteration may be required4 to 7 Indicates medium danger; additional research; modification to be done

8 to 10 indicate considerable danger; conduct research and make changes.

11+ = extremely high risk; bring about change

3.5.3 RULA

RULA method (McAtamney et al., 1993) evaluates muscular works of upper limbs in astatic way through an identification of angles in different body limbs, including repetitiveness and load handling analyses. Scores for each body segment of group A (arms, forearms, wrists, and wrist rotation) and group B (neck, trunk, and legs) were obtained using specific tables, in which scores for the use of musculature and manipulated loads were added. For this, a final score was obtained to identify the action levels and verify the required intervention for each typical posture.

Scoring:

1 and 2 indicate tolerable posture.

3 or 4 indicate that more research or a change may be required.

5 or 6 Implies further research, shortly to alter

7 = Examine and bring about change

3.6 ETHICAL CONSIDERATION

Several ethical considerations were considered before, during and after the data gathering process. The research was conducted adhering to relevant ethical considerations where human subjects are used (Mirza et al., 2023). These included voluntary participation, anonymity, and confidentiality, protection from harm, informed consent and fair presentation. The data collection process was gender neutral, religiously indifferent, making it comfortable for respondents of different beliefs, religions and races to participate. Before the data collection process began, the main purpose of the study was explained to the respondents, highlighting to them how critical it was for them to participate and provide authentic information. Approval to enter the study area was sought from the BoardEx General Manager to ensure that respondents would be able to participate freely and that the researcher would be following protocol. For confidentiality purposes, all personal information and data was only used for this study and was not disclosed to any third parties. It was made clear to all respondents that the data collected would be used solely for academic purposes, and that no incentives would be presented following data collection.

3.7 RELIABILITY AND VALIDITY OF DATA

Only content validity was employed in this study, as such, the designed structured questionnaire was first sent to the academic supervisor for content validity checks. The researcher also conducted a content analysis of data. This ensured that relevant aspects of the research topic were covered. Further, to ensure the reliability of the data, a thorough assessment using RULA and REBA score sheets (Appendix 1&2 respectively) was carried out.

3.8 DATA PRESENTATION AND STATISTICAL ANALYSIS

Microsoft Excel 2010 was used to create the initial database entry. SPSS 27.0 Software was used for the statistical analysis (SPSS, IBM Inc.). Age-related descriptive statistics were computed, encompassing percentages, means, medians, and standard deviations. Chi-square tests and linear regression were used to analyse the prevalence differences at a statistical significance threshold of 0. 05. For a better understanding of the study subject, the data were categorized and displayed in graphs and tables after collection.

CHAPTER FOUR: DATA PRESENTATION AND ANALYSIS

4.1 ERGONOMIC RISKS AND CONTRIBUTING FACTORS (AGE AND WORKING HOURS)

4.1.1 ERGONOMIC RISKS

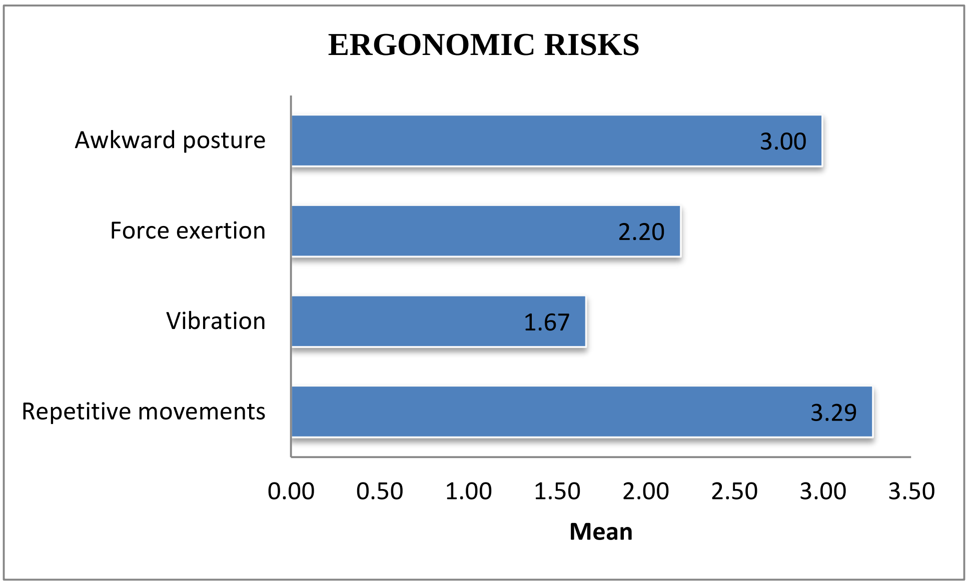

Figure 4.1.1 Ergonomic Risks

Figure 4.1.1 highlights that repetitive movements have the highest mean score of 3.29, indicating it is the most significant ergonomic risk. Awkward postures have the next highest mean score of 3.00, suggesting it is also a major ergonomic concern. Force exertion has a mean score of 2.20, which is lower than the previous two factors but still represents a notable ergonomic risk. Vibration has the lowest mean score of 1.67, implying it is the least severe ergonomic risk factor among factors studied.

4.1.2 AGE

Figure 4.1.2 Age distribution of woodcutters

The age distribution data provided in Figure 4.1 sheds important light on the demographic characteristics of the woodcutting workforce. At 15.4%, the youngest age range 18-25 years represents those just entering the field. The largest segment falls in the 36-45 year range at 38.5%. 19.2% represents the age group 26~35 years. It is worth noting that over 26.9% of respondents was 46-55 years old, signifying those able to sustain such demanding jobs into middle age, at least currently.

4.1.3 WORKING HOURS OF WOODCUTTERS

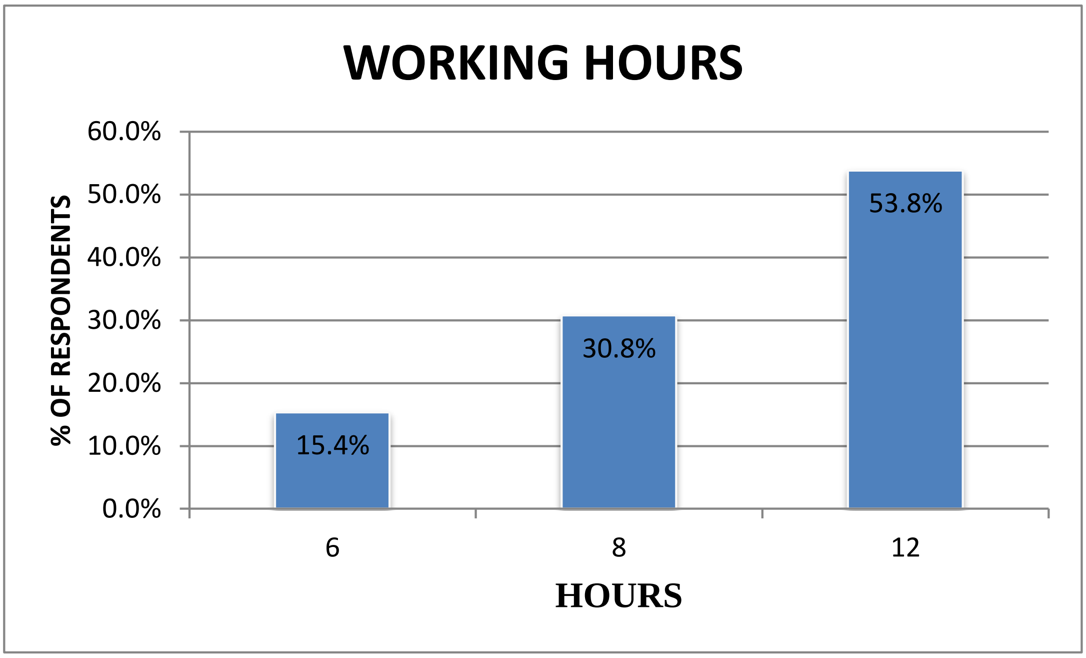

Figure 4.1.3 working hours of woodcutters

As shown in Figure 4.1.3, more than half of the employees at BoardEx work for more than 8 hours. This suggests that there is a significant portion of the workforce engaged in extended working hours. The distribution of working hours appears to be skewed towards the higher end, with a larger percentage of employees working longer hours 84.6% compared to those working shorter hours 15.4%.

4.1.4 ASSOCIATION BETWEEN ERGONOMIC RISK AND WORKING HOURS

Table 4.1.4 Association between ergonomic risk and working hours

Chi-Square Tests

	Value	Degrees of freedom	Asymp. Sig. (2-sided)
Pearson Chi-Square	24.626[a]	8	.002
Likelihood Ratio	24.981	8	.002
Linear-by-Linear Association	3.885	1	.004
N of Valid Cases	26		

To test the association between ergonomic risk and the working hours (job physical demand), a Pearson Chi square Test was done and the results are shown in Table 4.1.1. In the test, the null hypothesis was there no association between ergonomic risk and working hours. A P value of 0.002 was obtained at 95% level of significance thus, we reject the null hypothesis. Variables are not independent and there appears to be a significant association between ergonomic risks and working hours based on the chi-square test results.

4.1.5 ASSOCIATION BETWEEN ERGONOMIC RISKS AND AGE

Table 4.1.5 Association between ergonomic risks and age

Chi-Square Tests

	Value	Degrees of freedom	Asymp. Sig. (2-sided)
Pearson Chi-Square	23.480[a]	9	.004
Likelihood Ratio	22.605	9	.005
Linear-by-Linear Association	8.474	1	.003
N of Valid Cases	26		

Pearson Chi Squared test was used to test the association between ergonomic risks and age. These results suggest that the variables being tested are not independent and that there is a meaningful association or relationship between them. The low p-values (less than 0.05) provide strong evidence against the null hypothesis of independence.

4. 2 IDENTIFYING WORKING POSTURES AND MOST AFFECTED BODY PARTS USING REBA AND RULA

4.2.1 REBA AND RULA MEAN SCORES FOR WORKING POSTURES

Table 4.2.1 REBA and RULA Mean scores for working posture

Postures	REBA	RULA	N=26 N (%)
Bending	5	4.5	15.4%
Repetitive movements	5.6	7.5	34.6%
Awkward posture	5.1	5	23.3%
Squatting	4	5.5	7.2%
standing	5	6.5	19.5%

The results from the REBA and RULA assessments provide useful insights into woodcutters' risk of work-related musculoskeletal disorders. Table 4.2.1 shows that repetitive movements received the highest mean scores on both tools, indicating this posture poses the greatest risk, placing over one-third of woodcutters in a high-risk category.

4.2.2 REBA AND RULA MEAN SCORES FOR BODY PARTS AFFECTED

Table 1.2.2 REBA and RULA Mean scores for body parts affected

Body parts affected	REBA	RULA	N=26 N (%)
Wrist and hands	3	5	19.2%
Back and legs	5	6	46.2%
Neck and shoulder	7.3	5.9	34.6%

Table 4.2.2 demonstrates that the back and legs received notably high mean REBA and RULA scores, signifying nearly half of the studied woodcutters are at elevated risk of back injuries at 46.2%. This was followed by neck and shoulder contributing to 34.6 %. Lastly wrist and hands with 19.2% since some task are performed by machines.

4.3 CORRELATION VALUES BETWEEN RISK LEVELS PREDICTED BY RULA AND REBA IN WORK POSTURES

Table 4.3 Correlation between REBA and RULA in work posture

` Postures	Correlation coefficient REBA	RULA
Repetitive movements	0.682	0.766
Awkward postures	0.649	0.746
Bending	0.503	0.723
standing	0.634	0.711
squatting	0.374	0.634

The table above shows the highest correlation observed for repetitive movements (0.766 for RULA, 0.682 for REBA), indicating a strong alignment between the two ergonomic assessments methods in identifying the risks associated with repetitive work tasks. According to the p value, there is a significant correlation between the results acquired by the two evaluations. Similarly, high correlations are seen for awkward postures (0.746 for RULA, 0.649 for REBA), suggesting that both RULA and REBA effectively capture the ergonomic risk of these work postures. The correlation coefficients found for other postures - bending, standing, and squatting - were also predominantly above 0.5, demonstrating good concurrence between REBA and RULA ratings.

4.4 REBA AND RULA ASSESSMENTS BASED ON BODY PARTS AFFECTED

Table 4.4 REBA and RULA Assessments on body parts affected and tasks preformed

Body parts	RULA Score	REBA Score
Neck	50% 4	60% 3
Back	60% 5	70% 6
Arm	50 % 4	40% 5
Wrist	20% 3	40% 4
Leg	20% 2	30% 4
Shoulder	30% 3	20% 4

The above data on Table 4.4 shows specific body parts and work postures that pose the greatest ergonomic risks. This table provides the specific REBA and RULA scores for different body parts, along with the associated work activities. For the neck, the RULA score is 50% 4, indicating that more change will be required. The wrist scored 30% for RULA 3 and a REBA score of 40% 4 indicating medium danger where additional research is required. The highest REBA score was 70% 6, back being the most affected body part while leg scored 20% affecting the legs. The neck received RULA and REBA scores indicating moderate to high risk.

4.5 ASSOCIATION BETWEEN REBA, RULA SCORES AND JOB TASKS

Model	unstandardized coefficients		standardized Coefficients.		
	B	Std Error	Beta	*T*	*Sig*
Constant	3.447	.331		10.416	.000
REBA	.222	.283	0.252	-1.296	.442
RULA	-.250	.217	-.263	-1.151	.000
Postures	1.315	.140	1.024	2.523	.000

Figure 4.5 Associations between REBA, RULA and Postures

The regression model presented in Figure 4.5 suggests a complex relationship between the ergonomic assessment tools and the identified risk factors. P -value of less than 0.025 indicates statistical significance. Therefore, the correlation between RULA scores and risk factors identified is highly significant, as evidenced by the p-value of 0.000. In contrast, the low p-value of 0.442 for REBA scores means the relationship with other variables is not statistically significant. The finding that risk factors have the highest standardized beta coefficient of 1.024 reflects their outsized impact on musculoskeletal hazards. The unstandardized coefficient for the RULA score is -0.250, indicating an inverse correlation with the dependent variable. In contrast, the unstandardized coefficient for the REBA score is 0.222, suggesting a positive relationship with the risk factors.

CHAPTER FIVE: DISCUSSION OF THE FINDINGS

5.1 ERGONOMICS RISKS

The study found out that key ergonomic risks faced by woodcutters include vibration, force exertion, awkward working postures and repetitive motion. Repetitive movements received the highest mean score 3.29, the key reason why repetitive movements pose such a high risk for woodcutters is due to the physically demanding nature of their work and the prolonged periods during which repetitive motions are performed without adequate rest or safety precautions. This finding aligns with previous research by Chidawu and Chirimambowa (2020) that examined ergonomic risk factors among 100 small-scale woodcutters in Zimbabwe, determining repetitive motions to be a primary risk factor for developing pain and discomfort.

Adding on, the risk factors of repetitive movements, vibrations, awkward postures and force exertions all have statistically significant associations with age, as indicated from the study. It was found out that identified ergonomic risks relate to a woodcutter's age from 36 years to 55 years. This suggests that as woodcutters' age increases, their exposure to and risk also increases. A possible explanation is that biomechanical deterioration occurs over time as the body naturally ages, making older woodcutters more susceptible to developing musculoskeletal issues (Chidawu & Matewu, 2020). Repeated biomechanical stresses accumulated over a career may accelerate age-related functional declines in the joints, muscles and ligaments. Additionally, years spent performing high-force, repetitive tasks may lead to the development or worsening of underlying musculoskeletal conditions like tendonitis or osteoarthritis that then amplify exposures' harmful impacts on the body.

The current study results showed that ergonomic risk and prolonged working ours are significantly associated. Since longer work hours signify increased exposure duration to ergonomic hazards repetitive motions, heavy lifting, awkward postures and inadequate recovery time, the combined impact of prolonged work hours and ergonomic risk factors can elevate the likelihood of developing musculoskeletal issues. The results of this study emphasize the need for employers to implement comprehensive ergonomic interventions, such as job redesign, workplace adjustments, and regular breaks, to mitigate the negative impacts of physical job demands and ensure the well-being of their workforce. By addressing these ergonomic risk factors, organizations can not only improve employee health and safety but also enhance overall productivity and performance.

5.2 REBA AND RULA SCORES ON WORK POSTURES

The final scores from the Rapid Entire Body Assessment (REBA) and Rapid Upper Limb Assessment (RULA) tools showed that the majority of woodcutters exhibited symptoms of musculoskeletal disorders. The scores were dependent variables derived from posture analysis of the subjects, as outlined by Petrik and Petrik (2015). Additionally, REBA generally indicated moderate risk levels, whereas RULA projected considerably high risk levels. Research conducted by Domingo et al. (2012) found that RULA estimated 57% prevalence of work-related musculoskeletal disorders occurring at moderate frequencies. Key risk factors leading to elevated RULA scores involved sustaining inappropriate postures like keeping hands raised over the head or bending/twisting the body extensively, as well as work carried out hastily to finish tasks urgently. In another study, Matonda and Matiza (2020) identified high risk postures such as working with arms above shoulder level or standing for prolonged periods without the ability to change position among 150 woodcutters. These studies corroborate the significant biomechanical stresses woodcutters regularly experience in their occupations.

5.3 REBA AND RULA SCORES ON BODY PARTS AFECTED

The back/legs received notably high mean of REBA and RULA scores, signifying nearly half of the studied woodcutters are at elevated risk of back injuries. This is consistent with existing literature, such as a study by Machingura and Chidawu (2018) which reported a high prevalence of low back pain due to strenuous physical job demands like lifting and carrying heavy logs. Moreover, the data showed RULA identified greater proportions of high-risk scenarios compared to REBA. This may be because RULA provides a more sensitive evaluation incorporating force, repetition and individual vulnerability aspects (Woolley & Crane, 2020). However, both assessment tools detected meaningful risks that require mitigation efforts.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

The findings of this research conclude that BoardEx woodcutters face wide range of ergonomic risk as observed without them knowing the risk associated with their job tasks. The key findings of the study indicated that awkward postures and repetitive movements are the major ergonomic risks faced by woodcutters. The present research demonstrated that both work exposures (prolonged working hours) and individual factor (age) have an essential impact on the like hood of developing MSDs. Back pain among woodcutters was prevalent and a significant issue that poses detrimental effects on the health of wellbeing. REBA and RULA are the easiest and most effective methods for postural risk assessment in the workplace. This was an added advantage as both tools were more versatile and less expensive in terms of time. However, RULA is a more precautionary method to protect operations health during a targeted task.

6.2 RECOMMENDATIONS

- A detailed task analysis of the specific tasks performed by woodcutters should be conducted to identify movements, postures, forces involved and the job task. Understanding the specific demands of each task will help pinpoint potential ergonomic risks factors.
- An assessment of work practices and procedures should be conducted to identify any inefficient or hazardous practices that may contribute to ergonomic risks. This includes examining how tasks are performed, the use of tools and equipment, and the organization of work processes.
- Conduct regular ergonomic training and educational sessions to increase the knowledge and awareness of ergonomic principles.
- Establishment of a reporting system that addresses ergonomic concerns promptly, encouraging open communication between woodcutters and management to address issues effectively.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE

My name is **LONGINA TARIRO MUZADZI**, a student at Bindura University of Science Education doing an Honours Degree in **Safety, Health and Environmental Management**. I am currently carrying out research on assessment of ergonomic hazards using REBA and RULA among BoardEx woodcutters. You are required to assist in this research by providing your ideas. The information you provide will strictly be used for academic purposes only and will be treated as highly confidential.

SECTION~ DEMOGRAPHIC INFORMATION

Please tick the box representing your response or fill in the spaces provided

*NB * Do not write your name*

1. Age range.

18~25☐ 26~35☐ 36~45☐ 46~55 ☐

2. Marital status

Married ☐ single ☐

3. Experience at your current position

< 5 years ☐ 6-10 years ☐ above 10 years ☐

4. Highest level of education

none ☐ National certificate NC ☐ ☐ Diploma ☐

Other

SECTION B: CONTRIBUTING FACTORS

5. How often do you feel physically exhausted after work?

Never☐ Occasionally ☐ Always ☐

6. How long have you been working on the same task?

2 hrs.☐ 8hrs ☐ 12hrs. ☐

7. Do you know what ergonomic hazards are *Yes or No?* ☐

8. State the ergonomic hazards associated with your operation?

…………………………………………………………………………………………….

9. What measures did you put in place to reduce ergonomics?

…………………………………………………………………………………………….

10. How do you rate your work load?

Low ☐ average ☐ high ☐

11. Which activity do you use vibration tools or machines for more than 30 minutes?

……

……

12. What are the most affected body parts?

……

……

13. How are large objects carried?

……

……

14. Do you usually work alone or as a team?

……

……

15. What type of tools do you use for cutting boards?

……

……

16. How often do you receive safety training before starting work?

……

……

SECTION C: WRMSDs experience.

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APPENDIX 2: RULA S**CORE SHEET USED IN THE STUDY**

Appendix 3 : REBA SCORE SHEET

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