ASSESSMENT OF RISK FACTORS FOR MUSCULOSKELETAL DISORDERS AMONGST PROVINCIAL LAUNDRY WORKERS

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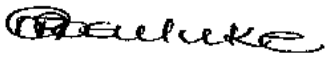
DECLARATION

I, Tinyiko Gladys Masuluke, declare that this report is my own work. It is submitted for the Degree of MPH Occupational Hygiene at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



_____ Date: 14 October 2022

(Signature of candidate)

DEDICATION

To the most high God, and to my late mother, Ndaheni Masuluke, may her soul continue to rest in peace. To my husband, Molemo Tsosane, and to my children for understanding and supporting me during the hard times.

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ABSTRACT

Background

Provincial laundry's primary function is to receive contaminated linen items from different hospitals and clinics within the district(s) for cleaning to ensure there is adequate supply of clean linen in the hospitals. Provincial laundry workers are responsible for this task. During cleaning of contaminated hospital linen items, laundry workers are exposed to several stressor categories such as physical, biological, chemical, psychosocial and ergonomics. There are health and safety concerns among provincial laundry workers, which are influenced by ergonomic related exposures.

Study Aim

The study aimed to evaluate task based ergonomic risk factors in the workstations of laundry workers in a provincial laundry in the Gauteng province.

Methods

This was a descriptive study where ergonomic risk factors for musculoskeletal disorder were identified and assessed. A convenient sampling technique was applied to select 112 laundry workers. The data was collected by means of a walk-through survey and observations of tasks. A survey sheet which included the assessment of ergonomic risk factors, and the hazards present per activity was used and existing control measure(s) and the number of employee(s) exposed were captured.

Demographic information and characterisation of the work activities performed by laundry workers were also collected. The Rapid entire body assessment (REBA) tool was used to assess work postures amongst provincial laundry workers.

Results

A total of 112 provincial laundry workers participated in the study. Approximately 97.3% of provincial laundry workers were African and 1.8 % were white. A total of 60.7% of laundry workers were found to be female and 39.3% were found to be male. The largest age group was 44–54 years, which comprised 46.4% of the laundry workers with a mean age of 44.5 years. The next age group, which was 24–34, comprised 22.3% of the laundry workers. A total of 28.5% of laundry workers were found to have 2–5 years working experience in the laundry.

Due to manual handling activities in the laundry, it was found that all tasks (9/9; 100%) required bending, prolonged standing, pushing and pulling, static and repetitive tasks. This is because the tasks are done in standing position and awkward postures are adapted by laundry workers. Apart from ergonomic risk factors, workplace environmental conditions such as heat, and noise were identified in some areas. All laundry tasks performed by provincial laundry workers posed a very high risk for the development of musculoskeletal disorders in terms of the calculated REBA scores.

Conclusions

It can be concluded that provincial laundry workers are exposed to numerous ergonomic risk factors due to the tasks that require manual handling. Based on the REBA scores, the laundry workers are at very high risk of developing musculoskeletal disorders. There is a need to implement interventions that may lower the risk of developing musculoskeletal disorders amongst provincial laundry workers. Intervention should be more focused on the modification of workplace design by alternating between tasks which require prolonged standing and elimination of the poor postures by training employees on correct postures while working.

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NOMENCLATURE

BMI	Body mass index
CCOHS	Canadian centre for occupational health and safety
EMS	Emergency medical services
GDoH	Gauteng Department of Health
HCFs	Health care facilities
HREC	Human research ethics committee
LBP	lower back pain
MSDs	musculoskeletal disorders
NIOSH	National institute of occupational safety and health
OWAS	Ovako work assessment system
REBA	Rapid entire body assessment
RULA	Rapid upper limb assessment
WRMDs	Work related musculoskeletal diseases

GLOSSARY

Awkward posture: Positions of the body that deviate significantly from the neutral position while performing work activities.

Biological agents: Any micro-organism, cell culture or human endoparasite including any which have been genetically modified, which may cause infection, allergy, or toxicity, or otherwise create a hazard to human health.

Ergonomics: The science of fitting workplace conditions and job demands to the capability of the working population.

Ergonomic risk factors: Conditions or activities in a workplace that can increase the likelihood of injuries or disorders on the musculoskeletal system.

Force: The mechanical or physical effort required to perform a task or to maintain control of equipment or tools.

Manual handling: Refers to moving items either by carrying, lowering, lifting, pulling and pushing.

Musculoskeletal disorder: Injuries or disorders of the muscles, nerves, tendons, joints, cartilage, and spinal discs.

Provincial laundry: A laundry that is not situated at the hospital but renders services to various health care facilities within the district(s).

Static posture: Physical exertion in which the same position is held throughout.

Upper crossed syndrome: When muscles of your shoulders, neck, and chest are out of balance (some are too weak or too tight).

Work related musculoskeletal disorder: Conditions in which the work environment and performance of work contribute significantly to the condition, and/or the condition is worsened or persists longer due to work conditions.

CHAPTER ONE: INTRODUCTION

This chapter provides a background to provincial laundry processes and health hazards related to handling and cleaning contaminated linen. It further explains in detail the ergonomic risk factors and related health risks that laundry workers are exposed to on a day-to-day basis.

The literature on risk factors for musculoskeletal disorders among laundry workers are very limited, therefore other studies focusing on the risk factors for MSDs in other sectors were reviewed in this report.

The reviewed articles presented in this report were searched from google scholar and PubMed databases. A combination of terms indicating the exposure, outcome and target population were used. For example, the terms “ergonomics risk factors laundry” or “ergonomics risk associated with laundry work” or “laundry ergonomics” or “laundry environmental conditions and ergonomics” or “ergonomics risk factors” were used. Only articles that were written in English were reviewed in this report.

1.1. BACKROUND:

Epidemiological studies have reported a causal relationship between biomechanical risk factors at work (i.e., awkward posture, repetitive movement, forceful exertion, manual material handling and prolonged static work) (1-3) and work-related musculoskeletal disorders(4, 5). A study conducted in Bangladesh reported repetitive motion, excessive force, and unnatural and static postures as a leading musculoskeletal risk factors in the hospital business (6). .

The hospital workers are exposed to biomechanical risk factors while lifting, carrying, washing, and changing of beds due to manual material handling of tasks (6).

A recent study carried out in a low-middle income country suggests that ergonomic related disorders are amongst the top health risks in certain groups of workers (7). A study done in Brazil reported health and safety concerns among laundry workers, which are influenced by ergonomic related exposures (8).

In South Africa, the Ergonomics Regulations of the Occupational Health and Safety Act, 1993 (Act no.85 of 1993) was promulgated in 2019 to protect the health and safety of any person who may be exposed to ergonomics in a workplace (9). According to regulation 6 of the ergonomics Regulation, an ergonomic risk assessment must be conducted in a workplace to identify all workers who may be affected by the ergonomic risks and how may be affected.

There is a dearth of literature in South Africa regarding ergonomic assessment of laundry worker's exposure to risk factors for the development of WMSDs. Only a limited number of studies in Africa reported exposure to work-related ergonomic risk factors among hospital laundry workers(10, 11).

Provincial laundry workers are a diverse population with a high risk of exposure to several stressor categories such as physical, biological, chemical, psychosocial and ergonomics(11, 12). Some studies investigate exposure to biological agents in hospital laundry settings (13-15) while other stressors are often given little attention.

Provincial laundry workers are responsible for sorting and washing soiled linen, drying, ironing/pressing, folding, packaging and labelling, mending torn linen and the distribution of clean linen to various health care facilities. Workers are exposed to repetitive motion, awkward body posture, and pulling and pushing wet, heavy linen

using trolleys, which may lead to the development of musculoskeletal disorders (MSDs) (16, 17).

Provincial laundries are responsible for providing a clean and continuous supply of linen to different hospitals in the province. A lack or delayed supply of hospital linen affects hospital activities and influences the quality of health care, mainly the safety of patients and their comfort (18).

In South Africa, there are in-house laundries that are located within hospitals which render the service from that specific hospital or clinics around the sub-district(s). Apart from in-house laundries, there are also provincial/regional/central laundries that are unattached to hospitals, which service health care facilities in one or two district(s) (19).

In Gauteng, there are five Health Districts and within the districts there are three provincial laundries that are unattached to hospitals. The laundries are situated in the Ekurhuleni health district, Johannesburg health district and Tshwane health district. This study focused on ergonomic risk factors among laundry workers in one selected provincial laundry based in Boksburg, in the Ekurhuleni health district, on the East Rand of Gauteng province. The provincial laundry renders services for Ekurhuleni and Sedibeng Health care facilities. The area was selected based on the amount of linen washed per day and the number of health care facilities being serviced.

1.2. PROBLEM STATEMENT

In South Africa, studies assessing risk factors for musculoskeletal disorders have been conducted in various work settings. A Study on steel plant workers (20), found that there was a “significant adjusted odds ratios for twisting and bending (OR 2.81; CI 1.02–7.73) and prolonged sitting (2.33; 1.01–5.37”.

Another study conducted among nurses in KwaZulu Natal (21) revealed that exposure to “bending (p=0.002), prolonged position (p=0.03) and transferring patients (p=0.004) were strongly associated with low back pain”. The findings of the study conducted among office workers in a private hospital indicated a significant association between exposures to certain administrative work that require repetitive motions and MSDs. The exposure includes tasks that require “frequent repetitive motions (80.3%, p = 0.001) and frequent bending of neck, shoulder, elbow, and wrist or finger joints (85.9%, p = 0.005)”. Continuous standing for a period of more than 30 minutes was required in certain amount of workers (22). Review of the literature did not reveal any studies on the assessment of risk factors for MSDs among hospital laundry workers in South Africa. Hospital laundry workers need to perform tasks that require them to assume prolonged and static working postures, perform work in awkward posture, repetitive movement, and perform manual material handling of tasks, which have been reported to be the risk factors for musculoskeletal disorders. A high rate of absenteeism among laundry workers was reported during the occupational health and safety meetings within the hospital laundries (23). It is, therefore, important to carryout studies to investigate the ergonomic risk factors among laundry workers.

1.3. JUSTIFICATION

In South Africa, ergonomic risks have been studied amongst health care professionals including nurses and doctors (24-26), but the support staff, which includes laundry workers, have not been considered. Therefore, this study may inform the provincial health department in Gauteng about the ergonomic risks present among laundry workers while performing their tasks. The study may also assist in the implementation of control measures that will improve the working conditions in laundries and promote

knowledge of ergonomic risk factors and associated health effects within the provincial laundry setting.

1.4. RESEARCH QUESTION, AIM AND OBJECTIVES

1.4.1. RESEARCH QUESTION

What are the ergonomic risk factors related to tasks performed by provincial laundry workers in Gauteng?

1.4.2. AIM

To evaluate the task-based ergonomic risk factors in the workstations of laundry workers in a provincial laundry in Gauteng.

1.4.3. OBJECTIVES

1. To identify ergonomic risk factors related to activities performed by laundry workers in a selected provincial laundry.
2. To assess ergonomic risk factors using the Rapid entire body assessment (REBA) tool among provincial laundry workers.

1.5. LITERATURE REVIEW

Ergonomic risk factors are the aspects of a job or task that impose a biomechanical stress on the worker. These may occur intentionally or unintentional depending on how the task is performed. These contravene the philosophy of ergonomics and may pose a risk to the health and wellbeing of employees at work (27).

According to the Global Burden of disease study conducted in 2016, musculoskeletal conditions were found to be the second highest contributor to global disability, with the

leading cause of disability found to be lower back pain (LBP) (28), and 20% to 33% of people are living with musculoskeletal pain across the globe (28).

WRMDs account for around 40% of the total compensated occupational injuries and diseases globally, and the symptoms are caused by work activities or work conditions, such as repetitive motion, excessive mechanical force concentration, forceful exertion, awkward posture, prolonged standing, and vibration(29, 30).

Various studies have confirmed that poor workplace and tool design, low quality working conditions, high workload and biomechanical risk factors when working results in high prevalence of musculoskeletal symptoms (29) (31, 32). Excessive repetition, awkward postures, and heavy lifting are the most common reported biomechanical risk factors with evidence for causing work related musculoskeletal disorders (5).

In a study conducted in Nigeria, involving manual material handlers, reported exposure to ergonomic risk factors such as awkward body postures, poor manual material handling, and prolong standing which predispose workers to work-related musculoskeletal disorders (33).

In South Africa, ergonomic risk factors have been studied in manganese and steel factories, among nurses and bank tellers, the agricultural industry, and office-based employees. These studies found that workers developed musculoskeletal injuries and diseases due to the tasks that they performed (20, 22, 34-36).

The main ergonomic risk factors include awkward posture, pushing and pulling, repetitive tasks, forceful exertion, and prolonged static work (37), which are commonly known as work-related risk factors for LBP, neck pain and other musculoskeletal

disorders (38-40). Laundry workers are at risk of developing upper crossed syndrome due to the task performed at the laundry. The condition is caused by awkward posture and repetitive tasks (41).

Laundry workers are at risk of LBP and shoulder injuries due to the tasks performed in their work environment. The tasks include working in an awkward posture, excessive forward bending to lift dry and wet linen, and forceful exertion (42). Laundry workers spend long hours on their feet and are mostly required to lift heavy loads (43).

Incorrect postures may lead to work related musculoskeletal disorders and generate different degrees of functional disability (44). A study conducted, involving laundry workers, on musculoskeletal symptoms and posture analyses found that the main body segments affected were shoulders, back, fists and legs (45).

Different categories of ergonomic risk factors

Ergonomic risk factors are divided into three categories: Individual risk factors (age, gender and workload from home), biomechanical exposure (poor workplace designs, forceful exertion, and repetitive task) and psychosocial stressors (workplace social support, workplace stress and job pressure).

Gender as an individual risk factor for ergonomics

A study by Hoy D et al., (46) on the global burden of LBP found that women are more susceptible to developing LBP than men due to hormonal and physiological difference between men and women. LBP was more prevalent (OR1.37, 95% CI) amongst women doing tasks that involved awkward posture (47) (48) and it increases during menopausal age (49), whereas in men the prevalent of LBP was associated with smoking ,age, hypertension and prolonged standing (50, 51).

Serrano et al. (52) conducted a study using gender-stratified multivariate adaptive regression splines models, where the factors that affect the development of MSDs for the shoulder, upper limb and neck were observed. The study found that factors affecting men were different from those affecting women in terms of MSDs. Activities such as repetitive motion and carrying or moving heavy loads affected more men, whereas women were mainly affected by working at high speed, lifting, and not taking breaks (52).

Age as an individual risk factor for ergonomics

Men and women between the ages of 20 to 30 experienced a decrease in muscle strength (53) when performing tasks that required gripping and moving an item. The 50 to 60 year olds took longer to complete a task compared the 30 year old men and women (53). A study done by Pohjonen (54) found poor work ability in employees between the ages of 40 and 55 compared to those of 30 years of age. These studies support the findings by Waters et al., (55) which showed that there are age related changes which may lead to reduced strength and mobility from the age of 40, and these may affect employees' ability to lift heavy objects. The increase in high levels of MSDs were associated with physical job demands (OR=1.46–72.81) in a group of workers who were 45 and older (56).

Pushing and pulling risk factor

Pushing and pulling are required to handle a large quantity of goods that need to be transported using wheeled trolleys from one place to another (57). According to Baril-Gingers et al., (58), nearly half of manual handling requires pushing and pulling.

Laundry bins are used by hospital laundry workers to transport linen items in and out of the laundry, which requires pushing and pulling (59). An epidemiological study done

in the Netherlands revealed that there is an association between lower back pain and pushing and pulling of objects (60). According to Cincinnati's National Institute for Occupational Safety and Health's investigation on pushing and pulling, 20 % of overexertion injuries and lower back pain in the United States of America has been related to the pushing and pulling of objects (61). A study conducted in a manganese factory in South Africa revealed that there is an association between the pushing and pulling of an object and more stringent classification for lower back pain (35).

According to Backhaus et al. (47) and Ciriello et al. (48) excessive load and repetition of tasks involving the pushing and pulling of objects may lead to the development of MSDs.

Forceful exertion

More force is applied by laundry workers during pushing and pulling of the laundry bins (59) due to the manual handling of heavy loads as compared to the tasks that involves handling of less loads. Offloading and loading heavy linen bags in and out of the truck requires laundry workers to apply force when gripping the linen bags (59). Lifting of heavy linen affects the lower back, shoulder muscles and tendons (62). Forceful exertion may cause cumulative trauma disorder in the hand-arm shoulder region (63). The tendons and muscles of a person are overloaded by exerting force or the load when performing a task or an activity in the workplace (37). Activities that require force include lowering, lifting or carrying, grip force, pushing and pulling (37). Exerted forces may cause a joint torque, shear and compression when the cart masses are operated manually (64).

Standards or guidelines on how to handle heavy loads manually have not been properly documented (65). A study done by Malchaire et al. (66) focused on the

relationship between pushing and pulling with factors of internal strain predisposed to body location, therefore, it remains a challenge to reduce the prevalence of MSDs. Cumulative load and overexertion are the main cause of musculoskeletal injuries (67)

Prolonged standing risk factors

Prolonged standing has been identified as a risk factor in a hospital laundry (10, 68-70) and employees exposed to this risk factor are at risk of lower limb disorders (71, 72). Hospital laundry workers are required to stand for longer periods when sorting the linen in preparation for washing due to the demand of the task (59). Hospital laundry workers experience long standing periods during pressing/ironing and folding of linen items in the laundry (59). Many employees are required to stand for long periods of time when performing their task without walking or sitting during their shift (73).

Based on the literature by Waters et al. (73) that was reviewed, there is evidence that standing for long periods at work may have serious health effects. These include leg pain, lower back pain, fatigues, heart problems and discomfort (73). According to review by McCulloch (74) seventeen studies reported prolonged standing to be associated with chronic venous insufficiency, pain in the lower back and feet, preterm birth and spontaneous abortion.

According to the Canadian Centre for Occupational Health and Safety's report, standing for long hours while performing a task can cause sore feet, varicose veins, leg swelling, neck and shoulder stiffness and fatigue. Furthermore, it reduces the supply of blood to the muscles (75).

Awkward Posture

While loading linen bags onto the transport, pulling and lifting is applied where the workers are exposed to awkward posture and twisting (70, 76) . There is evidence that working in awkward posture is associated with musculoskeletal disorders especially in the shoulder region (77-80). Laundry workers are prone to upper crossed syndrome due to the tasks that involve awkward posture and prolonged standing (41). Hospital laundry workers bend and twist the trunk, shoulder and elbow when pushing and pulling laundry bins filled with linen (59). During offloading and loading of linen bags into the truck, hospital laundry workers must bend and twist because of the heavy linen bags (59, 70, 76). Hospital laundry workers are exposed to awkward posture when sorting the linen items due to the physical demand of the task (59). Work related musculoskeletal discomfort and lower back injury have been associated with awkward, extreme and repetitive posture (81). A study done by Kivi and Mattila (82) used the computerised Ovako Work Assessment System (OWAS) method to analyse and improve the work postures of construction workers in the building industry. Observations of a task taking ninety minutes were made in 30 second intervals for a total of 6 457 postures. The results showed that 27.8% of workers were among cement workers who were working in awkward posture.

Repetitive motion

Repetitive motion has been identified as one of the risk factors at the laundry due to the tasks performed (68, 70). There are tasks in the laundry that require hospital laundry workers to perform repetitive motions, including sorting, ironing/pressing and folding linen items (59). Tasks that are repeated frequently for long periods can accumulate exertion and muscle tendon strain and fatigue (83).

However, when performing the same task there is an increase on the effects of repetitive motion, especially when forceful exertion and awkward posture are involved. When enough time is allocated between exertion the tendons and muscles can recover (83).

Psychosocial stressors for ergonomics

The conditions or activities in a workplace can increase the likelihood of injuries to or disorders in the musculoskeletal system (84). Studies in the past decade aimed to identifying the common risk factors for MSDs (85, 86). Low job satisfaction, poor social support at work and jobs that require excessive force or increased manual handling are the main causes of LBP (38, 87). A study by Amir Loghmani et al., (88) , showed an association ($p<0.05$) between musculoskeletal symptoms and low job satisfaction among Iranian office workers. Evidence from literature reveals that upper limb musculoskeletal complaints contribute to work related physical and psychosocial exposure (89-91). A minority of workers that experience musculoskeletal pain report becoming disabled or that they take longer sick leave (92-94). Psychosocial risk factors and lower back pain are often associated with leave of absence from work (95, 96). High strain jobs, such as working with hands above the shoulder level, among men and women across all ages are associated with disability retirements (97).

Methods used to assess ergonomic risk factors

Different methods have been developed to assess the risk of developing musculoskeletal disorders including self-reports, observational and direct methods (98). Observational methods involve the observation of workers by the assessor using either sheets or videotaping/photographing the workers' posture in relation to the

activities in the workplace. Self-reports include interviewing or using a questionnaire to identify physical and psychosocial risk exposure in the workplace. Direct methods include using instruments such as a goniometer and orthoranger that will be used to monitor the joint movement for the task performed in the workplace (98).

Risk factors for MSDs at work are identified most frequently by observational methods including the effect of ergonomic changes (99). Self-report methods have been used to collect data on physical and psychosocial exposure in different work settings, however workers perceptions of exposure is sometimes not reliable and accurate (98). A survey conducted amongst Ergonomics professionals about the methods used in ergonomics reported that observational methods are the most commonly used in the field of ergonomics as compared to direct methods. (100, 101).

Various observational tools have been used in various work settings to assess the tasks, posture, force and muscle in use in the workplace. These include the Rapid entire body assessment (REBA) (102), Rapid Upper Limb Assessment (RULA) (103), Quick Exposure Check (QEC) (104), Revised NIOSH lifting equation (105) and Ovako Working Posture Analysis System (OWAS) (106). These tools have been used to assess ergonomic risk factors related to musculoskeletal disorders.

CHAPTER TWO: METHODOLOGY

This chapter describes the methodology used to assess the ergonomic risk factors associated with developing musculoskeletal disorders amongst provincial laundry workers. It further explains the study's location, population, sampling, data collection, data analysis, data management and ethical considerations.

2.1. STUDY DESIGN

A descriptive study was conducted in a provincial laundry situated in the Ekurhuleni health district, on the East Rand of Gauteng. The researcher observed and assessed risk factors for musculoskeletal disorders that the provincial laundry workers were exposed to in their normal day-to-day activities.

2.2. STUDY SITE

The study was performed at a selected provincial laundry located in Boksburg in the Ekurhuleni health district, on the East Rand of Gauteng. The laundry is divided into laundry factory A and B. Both the factories perform the same activities. This laundry receives contaminated linen items from hospitals, clinics, and emergency medical services (EMS) for cleaning and provides adequate, continuous, and quality supply of clean, disinfected linen to all healthcare facilities within the Ekurhuleni and Sedibeng districts. Disinfection of linen includes bedding, theatre linen, dressing linen and clothing. The selection of the study area was based on the number of health care facilities (HCFs) where the laundry renders services. The laundry renders a service to 72 HCFs with an average of 20 000 items of linen washed per day (107).

2.2.1. Work organisation

Hospital laundry workers work 8 hours per day, 40 hours per week with a 15-minute tea break and a 45-minute lunch break. Sometimes they render the service over the weekend from 07h00 to 15h00 on Saturdays and 07h00 to 13h00 on Sundays, depending on work demands.

2.2.2. The process workflow

Figure 2.1: *Process Flow of the Hospital Laundry*

2.3. STUDY POPULATION

The study population consisted of laundry workers, male and female, working in a provincial laundry. Data was collected from November to December 2020. The provincial laundry had a staff complement of 234 workers of which 184 workers were laundry workers.

2.4. STUDY SAMPLING

A convenient sampling technique was applied to select/recruit 112 laundry workers. The participants were interviewed for demographic information and being observed while performing the tasks. All the provincial laundry workers who gave consent to participate were included in the study.

All laundry workers who were involved in the laundry processes such as offloading, sorting, washing, drying, preparation, ironing/pressing, folding, labelling/packaging, and loading were included in the study. Each workstation in the provincial laundry was assessed to identify the ergonomic risk factors that may pose a risk for musculoskeletal disorders for provincial laundry workers.

2.4.1. INCLUSION CRITERIA

All permanently employed laundry workers involved in tasks of offloading linen bags, sorting, washing, preparation, pressing, ironing, folding, packaging, and loading linen bags into the truck were included in the study. The laundry workers were selected as they are fully involved in the laundry activities.

2.4.2. EXCLUSION CRITERIA

Supervisors and interns were excluded from the study as they were not fully involved in the work activities. Interns were excluded due to the nature of their employment which involves short period of employment that can end or be terminated anytime.

2.5. DATA COLLECTION

2.5.1. Data collection tools

2.5.1.1. Questionnaire

Data were collected using an interviewer administered structured questionnaire (Appendix B). This was developed by the researcher and used to obtain the socio-demographic characteristics of hospital laundry workers. The questions included personal data such sex, age, race, and workplace data such as years of experience in the laundry, the area where the laundry workers were placed and how long they were placed in the area. The questions were developed after reviewing the literature (108).

2.5.1.2. Survey sheet

Data were collected by means of a survey sheet (Appendix A) during a walkthrough at the laundry. To gain more understanding of the job tasks and demands, the workers' movements were observed for seven hours each day over a two-day period. Task observations were done, and the following information was captured per activity: ergonomic risk factors, number of employees performing the task, and the control measures in place after each. The researcher observed the workers performing their task and ticked the ergonomic risk factors related to each task/activity. It took one and fifty minutes to complete the survey sheet. Photographs were taken to capture the posture and the lifting technique used to perform a task.

2.5.1.3. REBA tool

The validated REBA tool (Appendix C) was used to assess and evaluate the work posture of provincial laundry workers. The tool was used to assess the entire body posture and the risk associated with the task performed. The REBA tool is divided into two sections with section A covering neck, trunk, and leg posture and section B covering upper arm, lower arm, and wrist movement.

The score is located according to the position of body parts in section A and B. The additional score of +1 is added when the body part is twisted or bending in section A and additional score of +1 is added when shoulder is raised or arm abducted/ supported or leaning and when wrist is twisted or bent from middle in section B. All scores in sections A and B are summarised in Table A (added with load/force score) and B (added with coupling score) respectively. The added load score is based on the following: “If the load < 5kg, 0 is added”, “If the load is 5 to 10 kg, then +1 is added”, and “if load is 15 kg, +2 is added”. The coupling score is based on the following: “well fitted handless and mid-range power grip which is good then +0 is added”, “acceptable but not ideal hold or coupling acceptable with another body part which is fair, then +1 is added”, “hand hold not acceptable but possible which is poor, +2 is added”, “no handle, awkward, unsafe with any body part which is unacceptable then +3 is added”. The scores in Table C are the combination of Table A and B scores. Table C also has an activity score (one or more body parts are held for longer than one minute, or repeated small range actions more than four times per minute or large rapid changes in posture) to give the final REBA score. REBA score ranges between 1 to 11+ and the risk level is based on the score as shown in Table 2.1.

Table 2.1: REBA Score and Risk Level of Musculoskeletal Disorder.

REBA Score	**Risk Level of Musculoskeletal Disorder**
1	Negligence risk
2–3	Low risk, change may be needed
4–7	Medium risk, further investigation, change soon
8–10	High risk, investigate and implement change
11+	Very high risk, Implement change

(Adapted from Hignett et al., 2000)

2.5.2. Pilot study

The data collection tools were piloted in one of the hospital laundries that does not form part of the study. The purpose of the pilot was to assess if the survey sheet captured all the sections and activities present in the laundry and to check how long it took to complete the REBA tool. The researcher found that there were two sections from the workers' activities that were omitted from the initial survey sheet. The survey sheet was then amended accordingly and washing and preparation for ironing were included. The time taken to complete the REBA tool per individual was three minutes.

2.5.3. Quality Assurance

Working postures for provincial laundry workers were assessed and evaluated using a reliable and validated Rapid entire body assessment (REBA) method. The measuring tools were piloted to examine the feasibility. All study participants were briefed about the study prior to data collection.

2.6. DATA MANAGEMENT

Data from the questionnaire, survey sheet and assessment tool were captured into REDCAP software for further processing. Data were cleaned for errors before being imported into STATA version 13 software for analysis. Data were password protected and backed up on iCloud to protect and restore data in case of data loss on the computer.

2.7. DATA ANALYSIS

Data were analysed using STATA version 13 software. Descriptive analysis was done to summarise data from each workstation to compare risk indicators. Data were summarised using tables for ergonomic risk factors identified per task, the number of workers performing the task, and the existing control measures in place. A histogram graph was used to summarise the final REBA score per task. Minimum, maximum, and median REBA scores per task were summarised using a table. Frequency and percentage tabulations were used to describe demographic characteristics of provincial laundry workers.

2.8. ETHICAL CONSIDERATIONS

The study was approved by the Faculty of Health Sciences Human Research Ethics Committee (Medical) at the University of the Witwatersrand. See attached clearance certificate no: M200437 (Appendix D). Permission to conduct the study was granted by the Directorate: Special Projects under which laundries fall for the Gauteng Department of Health. The laundry manager was briefed about the study prior to data collection and the information sheet (Appendix E) was given to him to keep. Laundry workers were briefed about the study and the information sheet was given to them. The information sheet had the name of the researcher and their contact details. It was stated on the information sheet that the study was voluntary and if anyone wished to participate, they should sign a consent form (Appendix F). It was clearly stated that if they wished to withdraw from the study they could do so without any prejudice. The names of the study participants were not written on the data collection tools but coded for confidentiality purposes. The consent form and questionnaire were stored securely and only the researcher had access.

CHAPTER THREE: RESULTS

3.1. INTRODUCTION

This chapter describes the demographic characteristics of the study's participants and the ergonomic risk factors for musculoskeletal disorders per workstation. It further explains the REBA scores acquired per activity in an ordinal manner.

3.2. Pilot Study Results

A total of 27 hospital laundry workers were randomly selected to participate and all the participants were involved in laundry processes. It was found that hospital laundry workers were exposed to ergonomic risk factors. These included awkward body posture, excessive bending, repetitive tasks, prolonged standing, pulling and pushing, raising the hands above shoulder level, forceful exertion, lifting of heavy linen bags, sitting, and environmental conditions (noise, heat, illumination). The interdepartmental rotation happened monthly except for the workers that were placed in the sorting, offloading, and loading areas. It was found that the conveyer belt was dysfunctional during the pilot study, which required laundry workers to handle linen manually. The calculated REBA scores were very high in all areas.

3.3. DEMOGRAPHIC CHARACTERSISTICS

A total of 112 provincial laundry workers participated in the study. Approximately 97.3% of provincial laundry workers were African and 1.8 % were white. A total of 60.7% of laundry workers were found to be female and 39.3% were found to be male. The largest age group was 44–54 years, which comprised 46.4% of the laundry workers with a mean age of 44.5 years. The next age group, which was 24–34, comprised 22.3% of the laundry workers. A total of 28.5% of laundry workers were

found to have 2–5 years working experience in the laundry. Approximately 89.3 % of hospital laundry workers were found to be working in the same area for more than 6 months.

Table 3.1: Demographic characteristics of study participants (N=112)

Characteristics	n (%)
Sex	
Female	68 (60.7)
Male	44 (39.3)
Age (Years)	
<24	3 (2.7)
24-34	25 (22.3)
35-44	24 (21.4)
45-54	52 (46.4)
55-64	8 (7.1)
Race	
Coloured	1 (0.9)
African	109 (97.3)
White	2 (1.8)
Working experience (Years)	
<2	19 (16.9)
2-5	32 (28.6)
6-10	26 (23.2)
11-20	32 (28.6)
>20	3 (2.7)
Area placed	
Drying	2 (1.8)
Folding	37 (33.0)
Ironing/pressing	16 (14.3)
Labelling/packaging	12 (10.7)
Loading	6 (5.6)
Offloading	8 (7.1)
Preparation	8 (7.1)
Sorting	15 (13.4)
Washing	8 (7.1)
Duration in the area (Months)	
<3	8 (7.1)
3-6	0 (0)
7-12	100 (89.3)
13-18	2 (1.8)
19-24	0 (0)
>24	2 (1.8)

3.4. IDENTIFICATION OF ERGONOMIC RISK FACTORS RELATED TO LAUNDRY TASKS

a) Offloading of linen bags

When offloading linen bags from the truck, laundry workers raised their hands above shoulder level to reach the linen bags that were above the shoulder in the truck. During this task, forceful exertion was applied to pull the bags onto the floor. Due to the weight of the bag, which was more than 20 kilograms, the laundry workers were required to bend their lumbar when pulling the bags, as shown in Figures 3.1 and 3.2. Repetitive and walking tasks were applied as the work demand is very high. Laundry workers spent 15 minutes per load and 12 loads were offloaded per day. Eight male employees were exposed to the ergonomic risk factors mentioned above. The existing control measures in this area were nylon/nitrile knitted safety gloves that can prevent the workers from gripping the linen bag using their fingertips and the N95 respirators that prevent airborne particles from entering the respiratory system.

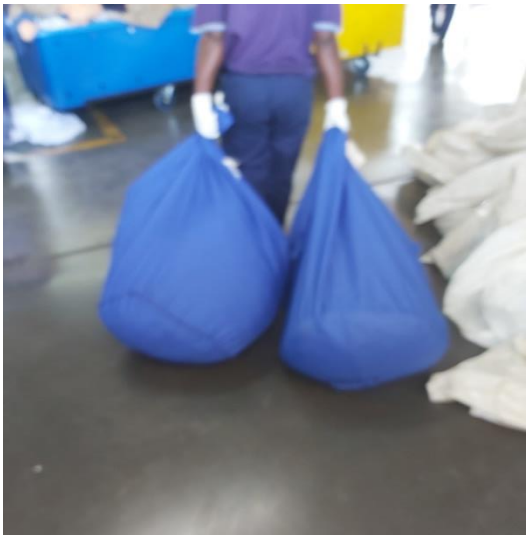

Figure 3.1: Pulling linen bags during during offloading

Figure3.2: Bending while pulling linen bags

b) Sorting of contaminated linen

Contaminated linen were sorted from the floor/ground, which required provincial laundry workers to bend excessively. All sorted linen were stored in the trolley, which was sometimes overloaded. Linen bags were lifted and emptied into the trolley, accompanied by prolonged standing, static posture, forceful exertion, repetitive motions, and awkward postures. Bending and pulling ergonomic risk factors are shown in Figures 3.3 and 3.4. Laundry workers spent 20 minutes per load and 12 loads were handled per day. Fifteen female laundry workers were exposed to the above-mentioned ergonomic risk factors in this area. The existing control measures in place included disposable gowns, N95 respirators, surgical gloves, hair nets, disposable shoe covers and natural ventilation.

Figure 3.3: Bending during sorting

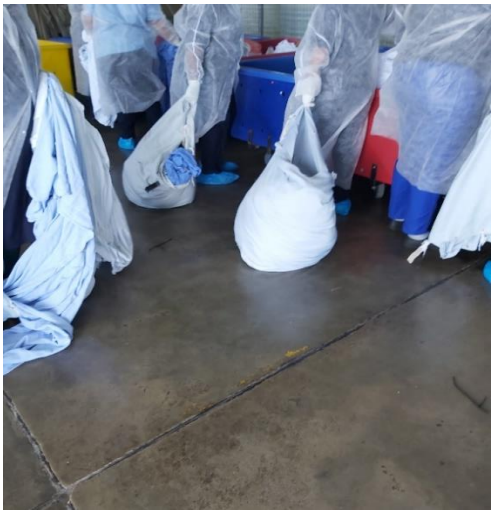

Figure 3.4: Pulling linen bags with contaminated linen

c) Washing

The wash operator (feeder) pushed the sorted linen in the overloaded laundry trolley to the washer conveyer belt. The linen was fed manually onto the conveyer belt where static task, repetitive task/action, long standing, pushing

and pulling, bending, noise, forceful exertion and working with hands above the shoulder ergonomic risk factors were observed. Prolonged standing, repetitive task, pulling and twisting are shown in Figures 3.5, 3.6 and 3.7. The provincial laundry workers spent eight hours on the task. Laundry workers in this area were exposed to chemical detergents. Eight male laundry workers were exposed to the above-mentioned ergonomic risk factors in this area. The existing control measures in place included gloves, disposable gowns and N95 respirators.

Figure 3.5: Standing, bending and twisting risk factors

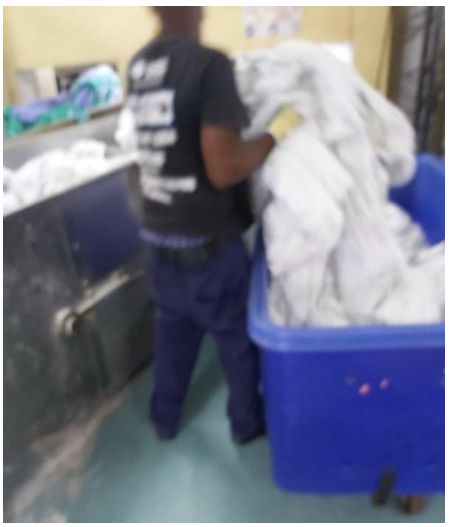

Figure 3.6: Repetitive task and lifting task

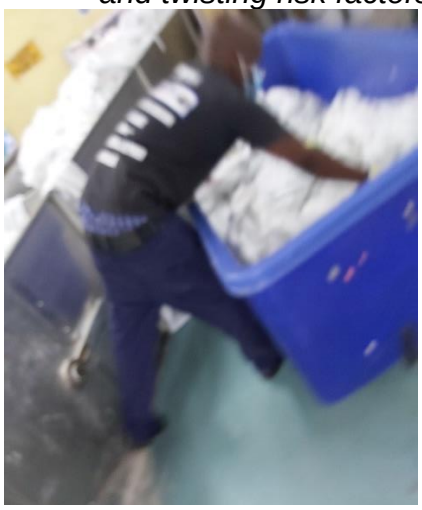

Figure 3.7: Bending during pulling of linen

d) Drying

Dried hospital linen coming out of the washer tunnel and dryers was automatically shuttled into the trolley where the washer operator (receiving) moved the trolley filled with linen to the preparation area. Pushing and pulling, repetitive task, long standing, noise from the machines, heat released by machines, bending, working with hands above the shoulder ergonomic risk factors were observed in this area. Two male laundry workers were exposed to the above ergonomic risk factors. The existing control measures include N95 respirators, hairnets, disposable shoe covers, surgical gloves and disposable gowns.

e) Preparation area

When linen came out of the dryer it was tangled, making it difficult for the employees who were at the ironing area to do the job quickly. The tangled linen was sorted in this area in preparation for ironing. The laundry workers spent eight hours on the task. Long standing, bending, excessive force, repetitive task, noise, heat, raising hands above the shoulder and static posture ergonomic risk factors were observed in this area. Bending, repetitive task/action/movement and prolonged standing are shown in Figures 3.8 and 3.9. The existing control measure was the N95 respirator. Eight male laundry workers were exposed to the above-mentioned ergonomic risk factors.

Figure 3.8: Bending task

Figure 3.9: Repetitive and prolonged standing

f) Pressing/Ironing area

Linen was received from the preparations area to be ironed or pressed. Prolonged standing, sitting task, repetitive task, static posture, bending, working with hands above shoulder level, poor illumination, heat, and noise risk factors were observed in this area. Raising the hands above the shoulder level, twisting the trunk and neck are shown in Figures 3.10, 3.11 and 3.12. The employees in this area spent eight hours on the task. Sixteen (six male and ten female) employees were exposed to the ergonomic risk factors mentioned in this area. Laundry workers who were doing the pressing task had access to adequate natural ventilation, whereas those performing the ironing task did not. N95 respirators, hairnets and non-adjustable chairs were part of the control measures in this task.

Figure 3.10: Twisting the trunk during pressing

Figure 3.11: Twisting the neck and raising the hand above shoulder

Figure 3.12: Raising the hands above shoulder level during pressing

g) Folding area

Repetitive task, static posture, long standing, siting task, forceful exertion, heat, awkward postures, working with hands above the shoulder, noise, poor illumination and bending risk factors were observed in this section. Neck bending, repetition of task and prolonged standing are shown in Figures 3.13 and 3.14. The employees folded the linen on the unadjusted tables and chairs and loaded it into the trolley. Thirty-three female and four male employees were exposed to the above-mentioned ergonomic risk factors in this area. The existing control measures available in this area were surgical masks and N95 respirators. The heavy linen was transported to the packaging area using a trolley, which was pushed, and forceful exertion was applied.

Figure 3.13: Bending and twisting the trunk

Figure 3.14: Neck bending and repetitive task during folding

h) Labelling/packaging linen bags

Bending, long standing, static task, forceful exertion, lifting of heavy linen bags, heat, cold, noise, poor illumination, sitting, pushing and pulling, working with hands above the shoulder level were the repetitive ergonomic risk factors that were observed in this area. Bending and repetitive task are shown in Figure 3.15. Twelve (two male and ten female) employees performed the labelling task in a sitting

position where non-adjustable tables and chairs were provided, and linen items were packaged in a standing position. N95 respirators and the conveyor belt were part of the control measures in place.

Figure 3.15: Bending and repetitive task during labelling of linen bags

i) Loading

Bending, static task, lifting of heavy linen bags, pushing and pulling, forceful exertion, repetitive task, excessive bending were risk factors that were observed in this area. Bending and lifting are shown in Figures 3.16 and 3.17. Employees pulled and lifted the linen bags into the truck. The task took 15 minutes per load. Six male employees were exposed to these risk factors. The existing control measures included gloves, N95 respirators and surgical masks.

Figure3.16: Pushing the heavy linen trolley

Figure 3.17: Lifting the linen bag into the truck

3.5. SUMMARY OF IDENTIFIED ERGONOMIC RISK FACTORS RELATED TO ACTIVITIES PERFOMED BY LAUNDRY WORKERS

A walkthrough survey was conducted to identify the ergonomic risk factors related to activities that were performed in the laundry.

As shown in Table 3.2, during the walkthrough survey it was observed that all of the laundry tasks required laundry workers to bend, stand for longer periods, engage in repetition of tasks and forceful exertion. It was also observed that laundry workers that were placed in the sorting, washing, preparation, folding, ironing/pressing, and labelling/packaging areas were exposed to environmental conditions such as heat and noise produced by machines.

Table 3.2. Ergonomic risk factors identified

Area surveyed	Activities	ERGONOMICS RISK FACTORS														Employee (s) exposed	Current control
		Sitting	Static	Prolonged standing	Repetitive	Pushing and pulling	Forceful exertion	Working with hands above the shoulder	Lifting heavy bag linen (>20kg)	Bending	Heat	Cold	Noise	Illumination	Total number of risk factors per task		
Offloading	Offloading linen bags	X	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	8	8	Gloves and N95 Respirators
Sorting	Sorting linen items	X	✓	✓	✓	✓	✓	✓	✓	✓	X	X	✓	X	9	15	N95 respirators Disposable gowns Hair nets Disposable shoe covers Surgical gloves
Washing	Feeding the linen into the washing machine	X	✓	✓	✓	✓	✓	✓	X	✓	X	X	✓	X	8	8	N95 respirators Disposable gowns Hair nets Disposable shoe covers Surgical gloves
Drying	Moving dried linen to pre-paration / folding area	X	✓	✓	✓	✓	✓	X	X	✓	✓	X	✓	X	8	2	N95 respirators

Legend:

✓ Risk identified

x Risk not identified

Table 3.2. Ergonomic risk factors identified (continued)

Area surveyed	Activities	ERGONOMICS RISK FACTORS														Employee (s) exposed	Current control
		Sitting	Static	Prolonged standing	Repetitive	Pushing and pulling task	Forceful exertion	Working with hands above the shoulder	Lifting of heavy linen bag (>20kg)	Bending	Heat	Cold	Noise	Illumination	Total number of risk factors per task		
Preparation	Preparation of linen for ironing	X	✓	✓	✓	✓	✓	✓	X	✓	✓	X	✓	X	9	8	N95 respirators
Ironing/pressing	Ironing/pressing of linen	✓	✓	✓	✓	✓	X	✓	X	✓	✓	X	✓	✓	10	16	Chairs, hairnets and N95 respirators
Folding	Folding linen items	✓	✓	✓	✓	✓	✓	✓	X	✓	✓	X	✓	✓	11	37	Tables, chairs and N95 respirators
Packaging/labelling	Packaging/ labelling of linen items into the linen bag	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	13	12	Tables and chairs, N95 respirators and conveyer belt.
Dispatch/loading	Loading linen bags into the truck	X	✓	✓	✓	✓	✓	X	✓	✓	X	X	X	X	7	6	Gloves and N95 respirators
Total tasks per risk factor		3	9	9		9	8	7	4	9	5	1	7	3			

Legend:

✓ Risk identified

x Risk not identified

3.6. ASSESSING WORK POSTURES OF PROVINCIAL LAUNDRY WORKERS USING THE RAPID ENTIRE BODY ASSESSMENT (REBA) TOOL PER TASK

3.6.1. Employee characteristics per task according to REBA scores

Demographic characteristics of provincial laundry workers performing laundry tasks are shown in Table 3.3. A total of 29.6 % of the workers in the folding area were female and were between the ages of 45 and 54 (n=31; 27.7%). Most of them had 2–5 years of work experience (n=11; 9.8 %) followed by 6–10 years (n=10; 8.9%) and 11–20 years (n=10;8.9%).

Table 3.3: Employee Characteristics According to REBA score

	Laundry task									
	Offloading	Sorting	Washing	Drying	Preparation	Ironing/pressing	Folding	Labelling/packaging	Loading/dispatch	Total number of employees
Characteristics	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**
Gender										
Male	8 (7.1)	0 (0)	8 (7.1)	2 (1.8)	8 (7.1)	6 (5.4)	4 (3.6)	2 (1.8)	6 (5.4)	44 (39.3)
Female	0 (0)	15 (13.4)	0 (0)	0 (0)	0 (0)	10 (8.9)	33 (29.6)	10 (8.9)	0 (0)	68 (60.7)
Age (years)										
<24	0 (0)	1 (0.9)	0 (0)	0 (0)	0 (0)	0 (0)	2 (1.8)	0 (0)	0 (0)	3 (2.7)
24-34	0 (0)	7 (6.3)	0 (0)	0 (0)	2 (1.8)	8 (7.1)	2 (2.8)	4 (3.6)	2 (1.8)	25 (22.3)
35-44	0 (0)	4 (3.6)	4 (3.6)	0 (0)	4 (3.6)	4 (3.6)	0 (0)	6 (5.4)	2 (1.8)	24 (21.4)
45-54	6 (5.4)	3 (2.7)	4 (3.6)	2 (1.8)	2 (1.8)	4 (3.6)	31 (27.7)	0 (0)	0 (0)	52 (46.4)
55-64	2 (1.8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (1.8)	2 (1.8)	2 (1.8)	8 (7.1)
Work experience (years)										
<2	0 (0)	7 (6.3)	0 (0)	0 (0)	4 (3.6)	4 (3.6)	4 (3.6)	0 (0)	0 (0)	19 (16.9)
2-5	4 (3.6)	5 (4.5)	0 (0)	0 (0)	0 (0)	6 (5.4)	11 (9.8)	4 (3.6)	2 (1.8)	32 (28.6)
6-10	2 (1.8)	2 (1.8)	6 (5.4)	0 (0)	0 (0)	2 (1.8)	10 (8.9)	2 (1.8)	2 (1.8	26 (23.2)
11-20	2 (1.8)	0 (0)	2 (1.8)	2 (1.8)	4 (3.6)	4 (3.6)	10 (8.9)	6 (5.4)	2 (1.8)	32 (28.6)
>20	0 (0)	1 (6.7)	0 (0)	0 (0)	0 (0)	0 (0)	2 (1.8)	0 (0)	0 (0)	3 (2.7)
REBA score	**13**	**12**	**12**	**12**	**12**	**11**	**11**	**12**	**14**	

3.6.2. REBA Score per task

Laundry tasks performed by provincial laundry workers were assessed using REBA and the scores were recorded per task as shown in Figure 3.18. The loading/dispatch task scored the highest with a REBA score of 13.5 and folding had the lowest score of 10.6.

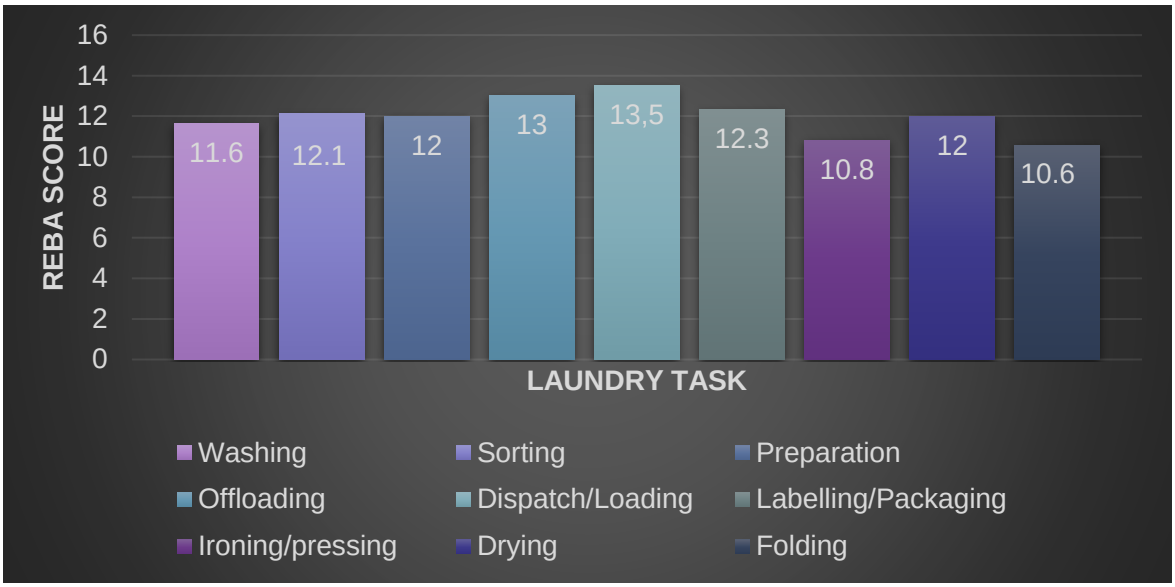

Figure 3.18: REBA scores per task

3.6.3. Ergonomic risk level for different tasks based on the calculated median of REBA scores

As shown in Table 3.4., the minimum REBA score was 6 in the offloading task while the maximum REBA score was 15 in the sorting task. Based on the calculated median of REBA scores, all the tasks performed by laundry workers exposed them to a very high risk of developing musculoskeletal disorders.

Table 3.4. Ergonomic risk level for different tasks based on the calculated median of REBA scores

Laundry Task	REBA score (min-max)	REBA score (median)	Risk level based on median
Offloading	12–14	13	Very High
Sorting	10–15	12	Very High
Washing	10–13	11.6	Very High
Drying	12	12	Very High
Preparation	11–13	12	Very High
Ironing/pressing	9–14	11	Very High
Folding	6–13	11	Very High
Packaging/labelling	11–13	12	Very High
Dispatch/loading	13–14	13.5	Very High

CHAPTER FOUR: DISCUSSION

4.1. INTRODUCTION

This chapter provides a description of how provincial laundry workers are exposed to ergonomic risk factors and discusses the outcome of the survey based on the tasks performed by provincial laundry workers, and the risk level of developing musculoskeletal disorders using the REBA assessment tool.

The aim of the study was to evaluate task-based ergonomic risk factors in the workstations of laundry workers in a provincial laundry in Gauteng. Most of the study participants were female between the ages of 45 and 54. The majority of participants had between 2 to 5 years' experience and others 11 to 20 years. Most of these females were placed in the folding area, whereas men were more often placed in the offloading, preparation and washing areas. The most identified ergonomic risk factors in all areas (9/9; 100%) were pushing and pulling, bending, repetitive task, and prolonged standing. Apart from the ergonomic risk factors, workplace environmental conditions such as heat, and noise were identified in some areas. All laundry tasks performed by provincial laundry workers placed them at a very high risk of developing musculoskeletal disorders in terms of the calculated REBA scores. It was found that job rotation occurred on a yearly basis.

4.2. LIMITATIONS OF THE STUDY

The study cannot be generalised to all provincial laundries as the study was conducted in one provincial laundry and the settings of other laundries may be different from the one studied. The study concentrated on observational methods, however, a combination of different methods can be used to assess the risk factors present in the laundry. The current study did not assess all the ergonomic risk factors outlined in the

literature review: e.g., psychosocial risk factors. The study can be expanded to explore the relationship between the risk factors involved and musculoskeletal pain amongst provincial laundry workers.

4.3. DISCUSSION

4.3.1. Employee characteristics

In this study, most of the participants were females as compared to males. This is similar to the comparative study conducted in Nigeria among laundry workers in the secondary and tertiary health facility, where the study population was largely females as compared to males in the secondary health facility. The difference was because the laundry operation is basically done manually, with females believed to wash better than males, leaving the males to carry out only tasks of ironing and supervising (109).

In the present study Men were more involved in tasks that required more physical power such as offloading, loading, ironing, and preparation of linen for ironing. A similar study by Kumar et al. (12) found that the laundry department activities demanded more physical activity such as lifting clothes, pushing linen in trolleys, and handling machines.

In this study it was noted that job rotation occurred on a yearly basis. Most employees were found to be repeating the same task for the whole 8-hour shift which constitutes 2 080 hours in a year. The finding is supported by the study by Wands et al. (68) who noted that few intra-departmental job rotations were observed in the laundry and as a result employees repeated the same task for the period of 8 hours and only rested during their two 15-minute breaks and single 30-minute lunch break per shift. Sometimes employees worked over the weekend due to job demand for eight hours on Saturday and four hours on Sunday. This contravenes the Basic Condition of

Employment Act, (Act no. 75 of 1997) which stipulates a maximum of 45 hours per week.

4.3.2. Ergonomic risk factors identified

Due to manual handling activities in the laundry, it was found that all tasks (9/9; 100%) required bending, prolonged standing, pushing and pulling, static and repetitive tasks. This is because the tasks are done in standing position and awkward postures are adapted by laundry workers.

Laundry jobs are classified as one of the jobs that require wrist movement due to repetitive task. A cohort study done by Lund et al.(110) showed that there is an increased risk of carpal tunnel syndrome with high levels of wrist movement.

In relation to prolonged standing exposure, a study conducted by Abd El-Wahed et al., (111) found that 91.2 % of laundry workers were exposed to prolonged standing while carrying out their tasks. In this study it was found that 100% of laundry tasks exposed laundry workers to prolonged standing due to high quantity of the linen items processed every day, pace of work and heavy workload. Prolonged standing has an impact in the industry as it lowers job productivity, increases medical costs and leads to occupational injuries (112).

In this study 36.8 % of laundry workers who were involved in four tasks (4/9; 44%) were exposed to heavy lifting of linen bags due to manual material handling. The tasks involved sorting, offloading, packaging/labelling and loading of linen bags. Similar to the study conducted by Abd El-Wahed et al., (111) where 83.6% of laundry workers were exposed to heavy lifting.

It was observed in this study that during the pressing task laundry workers were exposed to repetitive motions and raised their hands above shoulder level.

This finding is in line with the study done by Park (113) where job hazards for musculoskeletal disorder risk factors were analysed in a dry-cleaning establishment. The study showed that repetitive motion and raising the hands above shoulder level among workers in the pressing task was the ergonomic risk factor associated with the development of musculoskeletal disorders.

In this study 87 % of laundry workers who were involved in seven tasks (7/9; 78%) were exposed to noise released from laundry machines. These tasks included sorting, washing, drying, preparation of linen for ironing, ironing/pressing folding, and packaging/labelling. Similarly a study conducted by Abd El-Wahed et al., (111) found that 83 % of laundry workers were exposed to noise due to use of heavy machinery such as dryers and gas compressors during laundry processes. Exposure to high levels of excessive noise for a period of three to five years may cause noise induced hearing loss (114).

In this study a total of 33.2% laundry workers were exposed to heat released from ironing and pressing machines in the five tasks (5/9;55.6%). These tasks included ironing/pressing, preparation, folding, drying, and packaging/labelling. A comparative study done by Omoijiande et al. (108) about the hazardous exposure to hospital laundry workers revealed that hospital laundry workers were exposed to heat released from the pressing iron machine. Exposure to excessive heat affected employees' health and resulted in decreased job productivity (115). Prolonged exposure to excessive heat can cause heat cramps, heat exhaustion and heat stroke.

Most of the controls that were put in place were more appropriate for biological hazards. The controls included N95 respirators, hairnets, surgical gloves, disposable

gowns, and disposable shoe covers. Apart from biological controls, ergonomic controls such as tables at the folding area, chairs at the pressing, folding and labelling area, and a conveyer belt at the dispatch area were implemented. Chairs were not ergonomically friendly as these were not adjustable and did not move from side to side.

4.3.3. Risk of musculoskeletal disorders posed by tasks performed by hospital laundry workers

Based on the REBA scores found in this study, all nine tasks performed in the laundry exposed provincial laundry workers to very high risk of developing musculoskeletal disorders. The study is similar to a case study done in India which evaluated the work posture using RULA and REBA assessment tools. It was found that 53% of workers who were working in the same posture were at high risk of developing musculoskeletal disorders (116). However, the finding contradicted the pilot study done by Rui et al. (117) (2016), which revealed strong evidence (*P*=.001) that the task in the laundry department exposed laundry workers to medium risk of developing musculoskeletal disorders using the REBA assessment tool. This difference might be due to workplace setting/design and interventions implemented. Physical tasks that require repetitive use of certain body parts can affect the health and safety of a worker (118).

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1. INTRODUCTION

This chapter highlights that all laundry tasks performed by provincial laundry workers exposed them to a very high risk of developing musculoskeletal disorders. Corrective actions need to be implemented to reduce the impact of ergonomic risk factors for developing musculoskeletal disorders amongst provincial laundry workers.

5.2. CONCLUSION

Based on the observations it can be concluded that provincial laundry workers are exposed to numerous ergonomic risk factors due to the tasks that require manual handling. Based on the REBA scores, the laundry workers are at very high risk of developing musculoskeletal disorders. There is a need to implement interventions that may lower the risk of developing musculoskeletal disorders amongst provincial laundry workers.

5.3. RECOMMENDATIONS

The following corrective actions, if implemented, may assist provincial laundry workers with controlling their exposure to ergonomic risk factors. Training of provincial laundry workers on the correct posture and lifting technique by the occupational therapist may assist in reducing the risk of exposure education and awareness on ergonomic risk factors amongst provincial laundry workers. Development of policies and procedures to improve work practices related to ergonomics. Implementation of medical surveillance programme for early detection and treatment of musculoskeletal disorders. Regular servicing/maintenance of machines to reduce the noise exposure levels and noise assessment to be conducted by an occupational hygienist to quantify the amount of noise produced by machines.

Recommended controls for identified risk factors based on the laundry tasks

Offloading and loading of linen bags

To prevent musculoskeletal injuries arising from ergonomic risk factors involved from this task, laundry workers are advised to use a power grip instead of a pinch grip when lifting linen bags, and to continue using the safety gloves provided. Laundry managers should develop a policy that restricts the weight of linen bags with the maximum of 20 kilograms being an acceptable lifting weight. The policy should be communicated to all health care facilities. Procurement of mechanical dampers that will move linen bags from the collection area to the sorting area will eliminate the need for lifting and carrying heavy linen bags.

Sorting of linen item

The provision of sorting tables to prevent bending and lifting of linen bags should be considered. Monthly interdepartmental rotation is highly recommended to prevent repeated exposure and strain on the same muscles. Procurement of anti-fatigue matting to stimulate muscles of the calf is recommended. Laundry workers are encouraged to take short breaks during their workday and perform exercises for muscle stretching before and after work (119). An occupational therapist must be consulted for advice on a stretching routines programme.

Washing and drying of linen

Washer operators are encouraged to take rest breaks and micro-pause for 10 to 15 seconds to prevent fatigue and to allow muscles to recover. Laundry workers that are involved in the drying of linen are encouraged to use laundry rakes to reach linen that is hard to reach and that will force a worker to bend in an awkward posture.

Preparation of linen for ironing

Procurement of anti-fatigue matting to stimulate muscles of the calf is recommended in this area. Laundry workers are encouraged to take regular breaks and do stretching exercises. Performing elastic band exercises twice a week can reduce muscle strain on shoulders (120). Laundry workers are encouraged to use a power grip by grasping the linen item using the entire hand.

Ironing/pressing of linen items

Anti-fatigue matting is recommended in this area as the task performed requires prolonged standing. Performing elastic band exercises twice a week will help reduce muscle strain. Monthly interdepartmental rotation is recommended. Laundry workers in the pressing area should be provided with highchairs that are ergonomically friendly.

Folding of linen

Job rotation of linen items by size and type is recommended as it will provide some rest and variety in folding movement. Adjustable folding tables are recommended in this area to fit the workers' physical structure. In order to reduce repetitive motions and awkward postures, management should procure automated folding machines. Anti-fatigue matting is recommended to reduce fatigue. Procurement of ergonomic friendly chairs is highly recommended for the laundry workers that are conducting the task in a sitting position.

Labelling of linen bags and packaging

Laundry management should procure chairs that are ergonomically friendly for the task involved. Workers are encouraged to take breaks and do stretching exercises.

Further studies exploring the psychosocial and individual risk factors amongst provincial laundry workers are recommended.

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Appendix A: Ergonomics Risk Assessment Survey sheet

Date: _____ **Area surveyed: _____**

Hazards identified/Ergonomic risk factors	**Activities**	**Employee (s) exposed**	**Current control measure(s)**
Sitting Task	Offloading of linen bags from the truck		
Static posture			
Prolonged standing task			
Repetitive task			
Forceful Exertion			
Pushing and pulling task			
Working with hands above the shoulder			
Lifting of heavy linen			
Pushing and pulling task			
Environmental condition (Heat/Cold)			
Illumination (Poor/Good)			
Bending			
Noise			
Sitting Task	Sorting of linen items		
Static posture			
Prolonged standing task			
Repetitive task			
Forceful Exertion			
Pushing and pulling task			
Working with hands above the shoulder			
Lifting of heavy linen			
Pushing and pulling task			
Environmental condition (Heat/Cold)			
Illumination (Poor/Good)			
Bending			
Noise			

Hazards identified/Ergonomic risk factors	**Activities**	**Employee (s) exposed**	**Current control measure(s)**
Sitting Task	Washing of linen		
Static posture			
Prolonged standing task			
Repetitive task			
Forceful Exertion			
Pushing and pulling task			
Working with hands above the shoulder			
Lifting of heavy linen			
Pushing and pulling task			
Environmental condition (Heat/Cold)			
Illumination (Poor/Good)			
Noise			
Bending			
Sitting Task	Preparation of linen for Ironing		
Static posture			
Prolonged standing task			
Repetitive task			
Forceful Exertion			
Pushing and pulling task			
Working with hands above the shoulder			
Lifting of heavy linen			
Pushing and pulling task			
Environmental condition (Heat/Cold)			
Illumination (Poor/Good)			
Bending			
Noise			

Hazards identified/Ergonomic risk factors	**Activities**	**Employee (s) exposed**	**Current control measure(s)**
Sitting Task	Pressing/ironing of linen items		
Static posture			
Prolonged standing task			
Repetitive task			
Forceful Exertion			
Pushing and pulling task			
Working with hands above the shoulder			
Lifting of heavy linen			
Pushing and pulling task			
Environmental condition (Heat/Cold)			
Illumination (Poor/Good)			
Bending			
Noise			
Sitting Task	Folding of linen items		
Static posture			
Prolonged standing task			
Repetitive task			
Forceful Exertion			
Pushing and pulling task			
Working with hands above the shoulder			
Lifting of heavy linen			
Pushing and pulling task			
Environmental condition (Heat/Cold)			
Illumination (Poor/Good)			
Bending			
Noise			

Hazards identified/Ergonomic risk factors	**Activities**	**Employee (s) exposed**	**Current control measure(s)**
Sitting Task	Packaging of linen into linen bags/labelling linen bags		
Static posture			
Prolonged standing task			
Repetitive task			
Forceful Exertion			
Pushing and pulling task			
Working with hands above the shoulder			
Lifting of heavy linen			
Pushing and pulling task			
Environmental condition (Heat/Cold)			
Illumination (Poor/Good)			
Bending			
Noise			
Sitting Task	Loading linen bags into the truck		
Static posture			
Prolonged standing task			
Repetitive task			
Forceful Exertion			
Pushing and pulling task			
Working with hands above the shoulder			
Lifting of heavy linen			
Pushing and pulling task			
Environmental condition (Heat/Cold)			
Illumination (Poor/Good)			
Bending			
Noise			

Appendix B: Demographic information

INTERVIEWER-ADMINISTERED STRUCTURED INTERVIEW OF ASSESSMENT OF RISK FACTORS FOR MUSCULOSKELETAL DISORDERS AMONGST HOSPITAL LAUNDRY WORKERS

Identification number:

Introduction: To assess task based ergonomic risk factors in workstations of hospital laundry workers in a standalone laundry in Gauteng Province.

Objectives of the study is to:

1. To identify the ergonomic risk factors associated with activities performed by standalone hospital laundry workers in selected laundries in Gauteng.
2. To assess ergonomic risk factors of hospital laundry workers in selected laundries in Gauteng Province.

All information is strictly confidential and will be used for survey purposes only.

Instructions:

This is an interviewer-administered structured interview. Please answer the questions in the order given by the interviewer. Feel free to ask any question if the content is unclear. Due to the aim of the survey being to get an accurate understanding of the ergonomic risk factors in this context, please attempt to give the most honest answer possible.

Thank you for being willing to take part in this survey

General information

Sex	1 Male
	2 Female
	99. Other

Age-group	1. Under 24 years
	2. 24 - 34
	3. 35 – 44
	4. 45 – 54
	5. 55 -64
	6. 65 and above

Race	1. African
	2. Coloured
	3. Indian
	4. White
	99. Other

Years of experience in the laundry?	1. Less than 2 years
	2. 2-5 years
	3. 6-10 years
	4. 11-20 years
	5. Over 20 years

Which area are you placed in the laundry?	1. Offloading
	2. Sorting
	3. Washing
	4. Dryer
	5. Pressing

	6. Folding
	7. packaging
	8. Loading

How long you have been in this area?	1. Less than 3 months
	2. 3-6 months
	3. 7-12 months
	4. 13-18 months
	5. 19-24 months
	6. Over 24 months

Appendix C: REBA Employee Assessment Worksheet

A. Neck, Trunk and Leg Analysis

Step 1: Locate Neck Position

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

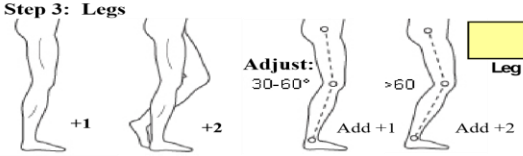
Neck Score

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 or 3 = low risk, change may be needed
4 to 7 = medium risk, further investigation, change soon
8 to 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

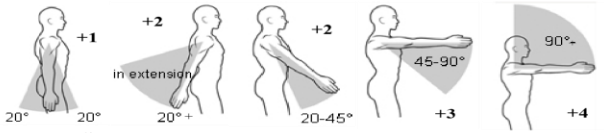
Score A (score from table A +load/force score)	Table C: Score B, (table B value +coupling score)											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	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

Final REBA Score

B. Arm and Wrist Analysis

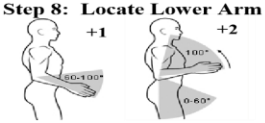
Step 7: Locate Upper Arm Position:



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

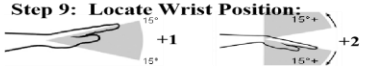
Upper Arm Score

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

Appendix D: Ethics Clearance certificate

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

R14/49 MsTG Masuluke

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M200437

NAME: (Principal Investigator)	MsTG Masuluke
DEPARTMENT:	School of Public Health Medical School University
PROJECT TITLE:	Assessment of risk factors for musculoskeletal disorders amongst hospital laundry workers
DATE CONSIDERED:	2020/04/24
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Ms G Kereteste and Dr B Nyantumbu-Mkhize
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2020/09/21

This clearance certificate is valid for 5 years from the date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the 3rd Floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.
I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to submit details to the Committee. I agree to submit a yearly progress report. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **April** and will therefore reports and re-certification will be due early in the month of **April** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

28/09/2020
Date

Appendix E: Participants Information Sheet
Part A

STUDY NUMBER: 678730

STUDY TITTLE: Assessment of risk factors for musculoskeletal disorders amongst hospital laundry workers

PRINCIPAL INVESTIGATOR: Tinyiko Gladys Masuluke

INSTITUTION: University of Witwatersrand

TELEPHONE NUMBER: 072 1360 369

Part B

Introduction:

Good day

My name is Tinyiko Masuluke working for Gauteng Department of Health under the Sub-Directorate Occupational Hygiene Risk Management at Head office. I am currently enrolled with the University of Witwatersrand under the School of Public Health for master's Degree in Public Health (Occupational Hygiene field). I am conducting a study on assessment of risk factors for musculoskeletal disorders amongst hospital laundry workers in standalone hospital laundry in Gauteng Province. Studies shows that the conditions or activities in a workplace can increase the likelihood of injuries or disorders on the musculoskeletal system.

Participation on the study is voluntary and you can withdraw at any time if you wish so, and nothing can be held against you. Before you are agreeing to participate in the study is very important to read and understand the explanation and the purpose of the study. You are invited to participate in the study. This information sheet will help you to decide whether you want to participate on the study. You are free to participate or not. If you are agreeing to participate on the study, you will be asked to sign this document to make sure you understood and agree to take part. You will also give the copy of the signed document to keep.

Purpose of the study

The focus of this proposed study is to assess the risk factors for musculoskeletal disorders amongst laundry workers per activity. The Rapid entire body assessment (REBA) tool will be used per worker per workstation for the participating laundry

workers in Dunswaart laundry within Ekurhuleni Health district. This will require observation by the principal investigator to assess and capture the scores according to the posture of an individual. In addition to this, photographs will be taken while performing your task, the aim of photographs is to capture the posture while performing the task. The photographs will be used as an evidence base for posture of the work performed.

There will be interview on demographic information of participating laundry workers that will take 3 minutes of their time.

Risk and benefits

There is no risk on participating in this study. The study will assist in the implementation of control measures that will improve the work conditions in laundries and to promote knowledge of ergonomic risk factors and associated health effects within the laundry setting.

Confidentiality

All information obtained during the study will be kept strictly confidential. Data that may be reported in the research report and scientific journals will not include any information that identifies you or names as study participants. There are no names on questionnaire, study participants will be coded and only the principal investigator will have access to codes and questionnaire.

Appendix F: Informed consent

Study Tittle: Assessment of risk factors for musculoskeletal disorders amongst hospital laundry workers

I hereby confirm that I have been informed by study investigator Ms. Tinyiko Masuluke about the nature, conduct, benefits, and risks of the study. I have also received, read, and understood the above written participant information sheet regarding the study. I am aware that results of the study will be anonymously processed into a study report and may, at any stage without prejudice withdraw my consent and participation in the study. I have had sufficient opportunity to ask questions and (of me on free will) declare my self-prepared to participate in the study.

PARTICIPANT (Laundry Worker):

_____ **Date:** _____

Name & Surname

Signature: _____

I, Tinyiko Masuluke, herewith confirm that the above participant has been fully informed about the nature and conduct of the above study.

Study Investigator

Tinyiko Masuluke_____ _____ _____

Printed Name **Signature** **Date**

Appendix G: Informed consent form for photograph

Assessment of risk factors for musculoskeletal disorders among Hospital laundry workers

Researcher: Ms Masuluke T.G

I _____ give consent to the researcher to take photos (but not my face) of myself while performing my task at the laundry and I understand the photos will only be used for the study.

Signature of participant: _____

Date: _____

Appendix H: Plagiarism declaration form

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

FACULTY OF HEALTH SCIENCES

PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

SENATE PLAGIARISM POLICY: APPENDIX ONE

I Tinyiko Gladys Masuluke (Student number: 678730) am a student registered

for the degree of Master of Public Health (Occupational Hygiene) in the academic year 2022.

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.
- I have included as an appendix a report from "Turnitin" (or other approved plagiarism detection) software indicating the level of plagiarism in my research document.

Signature: Date: 14 October 2022

Appendix I: Turnitin Report

FINAL SUBMISSION OF RESEARCH_REPORT_FOR_TINYIKO_MASULUKE-678730-1.docx

ORIGINALITY REPORT

3%	3%	4%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	wiredspace.wits.ac.za Internet Source	1%
2	"Ergonomics for Design and Innovation", Springer Science and Business Media LLC, 2022 Publication	1%
3	iosrjournals.org Internet Source	1%
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