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MUSCULOSKELETAL DISORDERS, WORK-RELATED FACTORS AND PAIN BELIEFS AMONG VISUAL-DISPLAY-UNIT USERS

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A dissertation submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of MSc Physiotherapy.

Gauteng, 2019

DECLARATION

I, Vanessa Redivo, declare that the work contained in this dissertation is my own, with the exception of certain excerpts indicated in the acknowledgement section.

This research report is being submitted in fulfilment of the requirements for a degree of Masters in Physiotherapy, at the University of the Witwatersrand, Johannesburg, South Africa.

This work has not been submitted for any other degree or examination at this or any other university.



_____ 30 May 2019

Vanessa Redivo Date

ABSTRACT

Musculoskeletal disorders (MSD) in the work place have increased with the use of visual-display-units (VDU). The aim of this study was to assess factors that influence MSD in VDU users in South Africa. This cross-sectional, observational study included one hundred and thirty-six (136) participants working with VDU for more than four hours a day and for at least 12 months. All participants completed self-reported questionnaires (demographics, MSD, work-related psychosocial factors) and an evaluation of work-station ergonomic risk factors. Participants with work-related MSD, completed the Fear Avoidance Beliefs Questionnaire (FABQ) and Pain Beliefs Perception Inventory (PBPI). Participants without work-related MSD were a reference group. Over-commitment was significantly higher ($p=0.041$) in the MSD group than in the reference group. Participants exercising four to five times per week were 2.47 times more likely to be in the reference group, with no MSD. There was no evidence of altered beliefs in the FABQ and PBPI within the MSD group. Over-commitment is an indication of intrinsic factors and personal characteristics. Interventions to address over-committed individuals may be needed to assist with MSD management. Further research is imperative before treatment plans can be generalised.

SUMMARY

Background

Musculoskeletal disorders in the work place have increased with the use of visual-display-units (VDU). The cost to the economy and the burden of the disease is a matter for serious concern. In recent years, research into understanding the phenomenon has resulted in an appreciation of the complexity of associated aspects contributing to musculoskeletal disorders. The need for a thorough understanding of the factors could further improve longitudinal studies to establish causation, as well as to allow precise intervention strategies for the work place and more specifically for the clinical setting in which physiotherapists operate.

The primary aim of this study was to determine a relationship between musculoskeletal disorders, individual demographics, ergonomic risk factors, and work-related psychosocial factors in VDU users. A secondary aim was to determine whether VDU users with musculoskeletal disorders have altered pain beliefs.

Method

One hundred and thirty-six (136) participants working with a VDU for more than four hours a day and for at least 12 months participated in this cross-sectional, observational study. All participants completed self-reported questionnaires to establish their individual demographics, the work-related psychosocial factors impinging upon them (in terms of the Effort-Reward Imbalance Model and Over-commitment), and their experience of work-related musculoskeletal pain (established through the Nordic Musculoskeletal Questionnaire). All participants were evaluated for ergonomic risk factors through the Rapid Office Strain Assessment (ROSA).

Of the 136 participants, 68 participants presented with work-related Musculoskeletal Disorders (MSD) and these 68 participants further completed the Fear Avoidance Beliefs Questionnaire (FABQ) and Pain Beliefs Perception Inventory (PBPI). The other 68 participants were considered to be a reference group free from work-related MSD.

Descriptive statistics were generated for each variable. All alpha levels were set to $p = 0.05$. A two-tailed Pearson correlation was calculated to determine the relationships that exist between the variables of ergonomic risk factors, the Effort-Reward Imbalance and over-commitment for the MSD group and the reference group respectively. Independent samples t-tests were run on the two groups to determine the differences between the respective demographics of the individuals, the Effort-Reward Imbalance and over-commitment scores, and the ROSA scores. A binary logistic regression model was used to further investigate the factors influencing the categorisation of the participants into either the MSD or the reference group. Further analysis, using Kendall's Tau-b, was conducted in the MSD group to determine the correlations between the variables of Effort, Reward, the Reward sub-scales, over-commitment, and the ROSA, FABQ and PBPI scores.

Results

The mean age and Body Mass Index (BMI) for the MSD group were 33.3 years (SD:±8.5) and 26.1 kg/m^2 (SD:±5.3) respectively, while the mean age and BMI in the reference group were 35.3 years (SD:±8.7) and 26.1 kg/m^2 (SD:±4.9) respectively. There were no statistically significant differences between sex, handedness, educational level, duration of exercise, number of days of leave taken, number of hours worked per week or hours worked per day. The work-station ergonomic risk factors were measured with the ROSA to establish a risk assessment score out of ten. The scores for the MSD group and the reference group were 4.5 (SD:±1.0) and 4.25 (SD±0.8) respectively ($p = 0.102$), and considered to be statistically insignificant. Work-related psychosocial factors, measured through the Effort-Reward and Over-commitment Questionnaire, found no statistically significant difference in the Effort-Reward Ratio between the MSD group, ratio 0.94 (SD:±0.2), and the reference group, ratio 0.90 (SD:±0.2), ($p=0.287$). Also, no differences between the sub-scales of esteem, promotion and security were found. However, over-commitment was statistically significantly higher in the MSD group, 14.9 (SD:±3.1) than in the reference group, 13.8 (SD:±3.4) ($p=0.041$). Since the scores for FABQ-W above 29/42 and for FABQ-PA above 13/24 were considered to be cut off points for poor outcomes, this population group was found to present with a low level of fear-avoidance beliefs, with the FABQ-work sub-score mean value being 6.5 (SD:±5.4), and the FABQ-Physical Activity mean value being 7.9 (SD:±6.3). The positive scores of the PBPI sub-scales are an indication for endorsing the pain belief. There was no significant evidence of altered beliefs in the PBPI with the mean values for mystery, permanence, constancy and self-blame being at the -1.1, -1.2, -1.1, -1.2 levels respectively.

Conclusion

There were insignificant differences between the MSD group and the reference group in terms of the personal demographics, ergonomic work-station set up and the Effort-Reward Ratio.

Since over-commitment is an indication of intrinsic factors and personal characteristics, the significant difference between the MSD group's over-commitment score and that of the reference group suggests that interventions and methods to empower individuals are needed.

This population of VDU users does not show altered pain beliefs, and further research is needed before treatment plans can be generalised to address pain beliefs. These findings indicate that practitioners should be holistic in terms of their management methods, including their assessment of all factors that influence work-related MSD. Work-related MSD in the work place is multi-factorial, and further research in the South African population is needed to establish relevant data pertaining to the VDU user.

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DEFINITIONS OF TERMS

Ergonomics: 'Ergonomics is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimise human well-being and overall system performance' [According to the International Ergonomics Association (IEA) (*International Ergonomics Association*, 2018)].

Catastrophising: Expecting or worrying about major negative consequences from a situation, even one of minor importance (Turner, Jensen and Romano, 2000).

Pain: An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage (*International Association for the Study of Pain*, 2018)

Pain beliefs: Pain beliefs represent patients' own conceptualisations of what pain is and what pain means for them (Williams and Thorn, 1989).

Pain-related psychosocial factors: Emotions, the social and environmental context, the sociocultural background, the meaning of pain to the person, and his/her beliefs, attitudes, and expectations, as well as biological factors surrounding the pain (Turk and Okifuji, 2002).

Visual Display Unit (VDU): A device/devices that display characters or graphics on a screen from a computer memory. It can include a keyboard to allow input of information. A VDU can also include a mouse to allow input of information (*Collins Dictionary*, 2018).

Visual Display Unit user: A VDU user/worker is defined as an individual working with a visual display unit that involves the use of a keyboard and/or mouse.

Work place: The area in which the research participant executes the work as per his/her job description.

Work-related musculoskeletal disorders (MSD): 'Impairments of body structures such as muscles, joints, tendons, ligaments, nerves, bones or a localised blood

circulation system caused or aggravated primarily by the performance of work and by the effects of the immediate environment, where the work is carried out' (Podniece and Taylor 2008 p.7).

Work-related psychosocial risk factors: An interplay between the social (environment) and psychological (individual) characteristics that could affect the health, satisfaction, effectiveness and performance of a worker (Lima and Coelho, 2018). Work-related psychosocial factors are defined as perceptions or the beliefs of workers about the way their work environment is organised (Mehta and Parijat, 2012).

Job content: job content is considered to refer to tasks done more than 50% of the day (Riccò *et al.*, 2016).

LIST OF ABBREVIATIONS

BMI	Body Mass Index
FABQ	Fear Avoidance Beliefs Questionnaire
FABQ-PA	Fear Avoidance Beliefs Questionnaire - Physical Activity
FABQ-W	Fear Avoidance Beliefs Questionnaire – Work
MSD	Musculoskeletal Disorders
PBPI	Pain Beliefs Perception Inventory
REDCap	Research Electronic Data Capture
ROSA	Rapid Office Strain Assessment
SD	Standard Deviation
VDU	Visual-Display-Unit/s

CHAPTER 1: INTRODUCTION AND SCOPE OF THE DISSERTATION

1.1 Introduction

We are living in amazing technological times where the likes of Samsung, Apple and Google are making leaps and bounds in efficiency and ease of work with regard to computers and computer accessories. However, this has come with a lifestyle change and associated musculoskeletal risks. There has been a dramatic increase in Visual Display Units (VDU) in the work place over a 20-year period, as much as doubling the percentage of users between 1989 and 2001 (Statistics Sweden, 2002). The employment growth in the computer systems sector for the period 2010 to 2020, has been projected to be between 7.0% to 22.0% (Csorny, 2013). This shows that VDU use is an interdependent part of the future of work-force. One may argue that this projection of more VDU users may be adding to the risk for work-related Musculoskeletal Disorders (MSD).

As a result of the increased use of VDUs, the prevalence of MSD has also increased (Ranasinghe *et al.*, 2011). MSD of the neck has the highest prevalence in VDU users - as high as 68.2% (Mirzaei *et al.,* 2014), and as low as 17%, with more studies consistently showing higher prevalence, comparatively of MSD in the neck than in the lower back area (Wahlstrom, 2005; Green, 2008; Wu *et al.*, 2012; Kaliniene *et al.*, 2013; Mirzaei *et al.*, 2014; Oha *et al.*, 2014). The second-highest MSD site in VDU users is the lower back area, with ranges from 6.6% (Wu *et al.,* 2012) to 72% (Mirzaei *et al.,* 2014). The other regions and ranges include the shoulder region (high and low) with respective levels of 65.27% (Mirzaei *et al.*, 2014) and 32% (Ranasinghe *et al.*, 2011), hand/wrists between 70% (Oha *et al.*, 2014) and 21% (Klussmann *et al.*, 2008), the elbow – higher area at 15% (Klussmann *et al.*, 2008) and lower area at 7.7% (Piranveyseh *et al.*, 2016), and the upper back - higher area at 37.8% (Piranveyseh *et al.*, 2016), and lower area at 26.2% (Wu *et al.*, 2012). This increase in MSD has resulted in an increase in sick days (absence from work), reduced efficiency, an increased burden of disease, and loss to the economy (Green, 2008; Matos and Arezes, 2015; Van Eerd *et al.*, 2016).

MSD has been documented as multi-factorial (Devereux, Vlachonikolis and Buckle, 2002; Korhonen *et al.*, 2003; Wahlstrom, 2005; Green, 2008; Wahlstedt *et al.*, 2010; Sonne, Villalta and Andrews, 2012; Kaliniene *et al.*, 2013; Oha *et al.*, 2014; Matos and Arezes, 2015). These multi-factorial issues include the following: the complexity of the work environment, the ergonomic setup, sustained non-neutral postures, force, static low load, static postures, sitting time, repetitive movements, psychological and social factors, a high perceived work load, and individual factors (Devereux, Vlachonikolis and Buckle, 2002; Korhonen *et al.*, 2003; Wahlstrom, 2005; Green, 2008; Wahlstedt *et al.*, 2010; Sonne, Villalta and Andrews, 2012; Kaliniene *et al.*, 2013; Oha *et al.*, 2014; Matos and Arezes, 2015).

The VDU worker's risk factors for MSD include muscular load, non-neutral postures, extreme positions, repetitive movements, force, visual demands, the duration of time spent at work, the duration of time spent in front of the VDU, associated psychosocial work demands, such as mental stress, job control, support, work style and technique, perceived tiredness, inactivity, smoking, socioeconomic factors, sex, and the work-station set-up (Korhonen *et al.*, 2003; Wahlstrom, 2005; Green, 2008; Das and Ghosh, 2010; Wahlstedt *et al.*, 2010; Zakerian and Subramanian, 2011; Wu *et al.*, 2012). Long periods of time at a poor work station and poor rest cycles evidently result in increased reports of MSD (Korhonen *et al.*, 2003; Das and Ghosh, 2010; Kaliniene *et al.*, 2013), and specifically, the longer the experience of working with a computer, the stronger the propensity for neck complaints (Kaliniene *et al.*, 2013). The risk of MSD escalates with a combined increase in the number of physical and psychosocial risk factors (Devereux, Vlachonikolis and Buckle, 2002; Widanarko *et al.*, 2015). Gender also appears to play a part in the risk for MSD, and this could be due to the different biological physiologies of the sexes, the influences on gender roles, and the increased risks associated with psychosocial factors (Maakip, Keegel and Oakman, 2016). The physiology was beyond the scope of the study.

Psychosocial factors in particular have been an area of increased interest. More research is needed in respect of the specific psychosocial risks associated with MSD to manage MSD more effectively (Zakerian and Subramanian, 2011; Myhre *et al.*, 2013). The literature assessing psychosocial risk factors associated with MSD in VDU users highlights the following: computer-related problems, job control and social

interaction (Zakerian and Subramanian, 2011), increased work demand, greater work experience, significant quantitative and average cognitive work requirements (Kaliniene *et al.*, 2013), considerable demands associated with the job, limited job influence and development, a low level of job satisfaction, and poor interpersonal relationships and leadership (Yue *et al.*, 2014), mental demands, limited job control (Devereux, Vlachonikolis and Buckle, 2002), and limited social support (Devereux, Vlachonikolis and Buckle, 2002; Wahlstedt *et al.*, 2010), high demands and stress (Wahlstedt *et al.*, 2010).

The outcome measures used in the studies (Devereux, Vlachonikolis and Buckle, 2002; Wahlstedt *et al.*, 2010; Zakerian and Subramanian, 2011; Kaliniene *et al.*, 2013; Myhre *et al.*, 2013; Yue *et al.*, 2014) include the assessment tools of the Demand-Control Model and the Effort-Reward Imbalance Model. The Effort-Reward Imbalance Model and associated Over-commitment appears to be a valuable tool to assess work-related psychosocial risk factors. The Effort-Reward Imbalance Model claims that should there be a concerted effort but a limited reward - defined as an imbalance and known as non-reciprocity - the participant could suffer from a continuous stress response and negative emotions. The opposite is true and where effort meets reward, the participant experiences well-being and good health (Siegrist, 1996).

Other constructs that also need attention are the health and pain beliefs that develop and contribute to ongoing MSD. In order to understand the psychosocial factors, one needs to understand the influence of beliefs, cognitions and behaviours (Baird and Sheffield, 2016). The Fear-avoidance Belief Questionnaire (FABQ), or variants thereof, is often used in research to determine pain-related psychosocial factors in the work place (Vowles and Gross, 2003; Coggon *et al.*, 2012; Myhre *et al.*, 2013; Oha *et al.*, 2014). FABQ is a measure of a patient's belief that physical activity would of necessity lead to increased harm (Waddell *et al.*, 1993).

The fear-avoidance model revolves around the premise that fear of pain will have an effect on the continuation of the disability and an increased duration of the pain experience (Lethem *et al.*, 1983). Fear avoidance remains one of the strongest predictors of prolonged pain, delayed recovery and absence from work (Vowles and Gross, 2003; Marchand *et al.*, 2015). The need to address fear-avoidance beliefs and

work-related fears in treatment is important if the patient is to return to a positive situation of physical capability at work (Vowles and Gross, 2003). By addressing these beliefs and fears, it would be possible to positively influence the individual's levels of pain intensity, activity, physical capability, distress and functioning (Lethem *et al.*, 1983).

Mhyre *et al*., (2013) investigated various aspects of the above components, namely FABQ, the effort-reward imbalance and over-commitment and demand-control at work for patients who took sick leave for neck and back pain, and these same aspects for a reference group. These authors found a unfavourable Effort-Reward Ratio, a higher effort than reward, known as non-reciprocity, and a higher level of over-commitment in the pain population than in the reference group. Job factors and over-commitment were found to be significantly associated with the FABQ work variable (FABQ-W). The higher the perception of the reward was, the lower the FABQ-W score. The study concluded that psychosocial factors are significantly and strongly associated with fear-avoidance beliefs about work. As such, the need to focus on work-related factors in patients experiencing pain becomes vital for the management thereof (Myhre *et al.*, 2013).

Other beliefs, including somatising tendencies (Coggon *et al.*, 2012), also form part of the pain experience. Pain beliefs can affect the way a patient perceives his/her functioning, treatment and experience of pain (Williams, Robinson and Geisser, 1994). Addressing the individual's pain beliefs has been found to result in better functional outcomes (Williams, Robinson and Geisser, 1994; Baird and Sheffield, 2016). Coggen *et al.,* (2012) hypothesised that cultural beliefs, physical activities and mental health have an effect on MSD.

In the South African population, the role of pain beliefs, somatising tendencies, cultural beliefs, physical activities and mental health in VDU needs to be assessed and established before any conclusions regarding evidence-based interventions can be made.

1.2 Problem Statement

The reasons for MSD in the work place are multi-factorial. As such, discovering which factors play a role, and the relationship between them and MSD, could result in better intervention methods. Pain beliefs and fear-avoidance behaviours perpetuate pain. The role of work dynamics also plays a part in this respect. The relationship between MSD individual factors, the Effort-Reward Imbalance Model variables, over-commitment, the ergonomic work-station set up, fear-avoidance behaviour and pain beliefs has not been established in the work place in South Africa.

The work-station set-up has been mentioned as a risk factor; however, findings in this respect have proved to be inconsistent. As such, the relationship between ergonomic risk factors in MSD and the reference group needs to be established. Since the relationships between individual factors, ergonomic work-station risk factors, psychosocial factors, pain beliefs and MSD have not been studied in the South African population, this research could add to the body of knowledge and assist with specific interventions.

1.3 Research Question

What is the relationship between MSD, individual demographics, the Effort-Reward Imbalance Model variables, over-commitment, ergonomic risk factors and pain beliefs among VDU users in South Africa?

1.4 Aims of the Study

The first aim of the study was to determine the relationships between MSD, individual demographics, the Effort-Reward Imbalance Model Variables, over-commitment and ergonomic risk factors in VDU users. The second aim was to determine the fear-avoidance and pain beliefs of VDU users.

1.5 Objectives of the Study

The objectives of this study were to:

1. Describe the differences in demographics, the Effort-Reward Imbalance Model variables, over-commitment and the ergonomic risk factors for VDU users with MSD and these same aspects for a reference group.

2. Determine the relationships between effort, reward, over-commitment and the ergonomic risk factors in VDU users with MSD and these same relationships in a reference group.
3. Describe the type of MSD and the associated pain beliefs using the Fear Avoidance Beliefs Questionnaire (FABQ) and the Pain Beliefs Perception Inventory (PBPI) in VDU users with MSD.
4. Determine the differences between males and females in the MSD group in respect of effort, reward, over-commitment, FABQ and PBPI.
5. Determine the relationships between effort, reward, over-commitment, ergonomic risk factors, FABQ and PBPI in the MSD population.

1.6. Hypotheses

1.6.1 Hypothesis

Musculoskeletal disorders are positively correlated with a high-risk ergonomic work-station set up, as well as psychosocial factors, work factors of a concerted effort and limited rewards (non-reciprocity) and high levels of over-commitment. The visual display unit users have altered pain beliefs, as identified by the assessment tools, FABQ and PBPI.

1.6.2 Null Hypothesis

Musculoskeletal disorders are not correlated with a high-risk ergonomic work-station set up, psychosocial factors, work factors of a concerted effort and limited rewards ratio (non-reciprocity) and a high level of over-commitment. The visual display unit users do not have altered pain beliefs, as identified by the assessment tools, FABQ and PBPI.

1.8 Significance of the Study

To the author's knowledge, there is no baseline prevalence study, nor correlation studies investigating the relationships between individual demographics, ergonomic risk factors, the Effort-Reward Imbalance Model and over-commitment in the VDU user in the South African population. Establishing pain beliefs in the VDU population in South Africa has also not yet been investigated. Assessing MSD in the VDU user could determine South African baseline prevalence scores. These baseline scores could then be used to establish changes in the interventions that are implemented.

Current evidence of work-place intervention programmes has shown varied effects, and the weak correlation of MSD with the ergonomic risk factors established in studies suggests that intervention programmes should not include work-station adjustments only. Furthermore, the complexity of MSD factors and evidence showing holistic interventions that would affect the outcomes of this study could motivate physiotherapists, occupational health and safety professionals, as well as researchers, to explore the application of the Effort-Reward Imbalance Model and associated over-commitment in assessments. Results of the study could be useful in interventions to address the imbalance between efforts and rewards, and over-commitment in the employee suffering from MSD.

11.9 Outline of this Dissertation

The following chapter discusses and critiques the literature through the four identified themes, namely, MSD, VDU, risk factors for work-related MSD, pain, and associated pain beliefs. The literature review further discusses and examines the assessment tools and questionnaires used in the data collection process. Chapter 3 elaborates on the methodology of the study, according to "STrengthening the Reporting of OBservational studies in Epidemiology (STROBE)" (von Elm *et al.*, 2014). Chapter 4 discusses the results pertaining to the objectives of the study. A comprehensive discussion then follows in Chapter 5, which also includes the strengths and limitations of the research process, and finally presents the conclusions.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction to the Literature Review

Owing to the multi-factorial nature of the work related to MSDs (Devereux, Vlachonikolis and Buckle, 2002; Korhonen *et al.*, 2003; Wahlstrom, 2005; Kaliniene *et al.*, 2013; Widanarko *et al.*, 2015), the analysis of the literature was conducted under various themes.

Since the objectives were differentiated into MSD and ergonomic factors (including psychosocial factors), and MSD and pain beliefs, the literature review was divided in two main sections. In order to understand the relationship, a thorough review of each factor was primarily investigated in the body of literature and perceived in terms of a work-related context. Deeper analysis of the research was conducted by reviewing the factors pertinent to the VDU ergonomics and MSD, as well as to work-related MSD and pain beliefs.

The need to understand and critically analyse all available knowledge is important in order to prevent MSD, the latter ultimately affecting an individual's quality of life, as well as his/her organisational productivity (Shuai *et al.*, 2014; Shariat *et al.*, 2016). With the above statement in mind, a literature search of Pubmed, ScienceDirect, EbscoHost, and ProQuest databases was conducted. Key words for the themes are included in Table 2.1. A review of the reference lists in articles was also undertaken to widen the search. Results were refined using combinations of the key words set out below.

Table 2.1 Key words for literature search strategy

Theme	Key words
Musculoskeletal disorders	Musculoskeletal disorders, work-related musculoskeletal disorders, musculoskeletal pain, musculoskeletal symptoms, repetitive strain injuries, work-related upper extremity/lower extremity, back, neck, and shoulder pain
Visual Display Unit	Visual display unit, computer, laptop, visual display terminal
Risk factors	Psychosocial, psychosocial risk factors, ergonomics, ergonomic risk factors
Pain	Pain, chronicity, chronic pain disability, fear-avoidance beliefs, health beliefs, pain perception, pain behaviour

The objectives of the study assisted in the development of the literature review themes. These themes were used as a framework for the literature review and are presented visually in Figure 2.1.

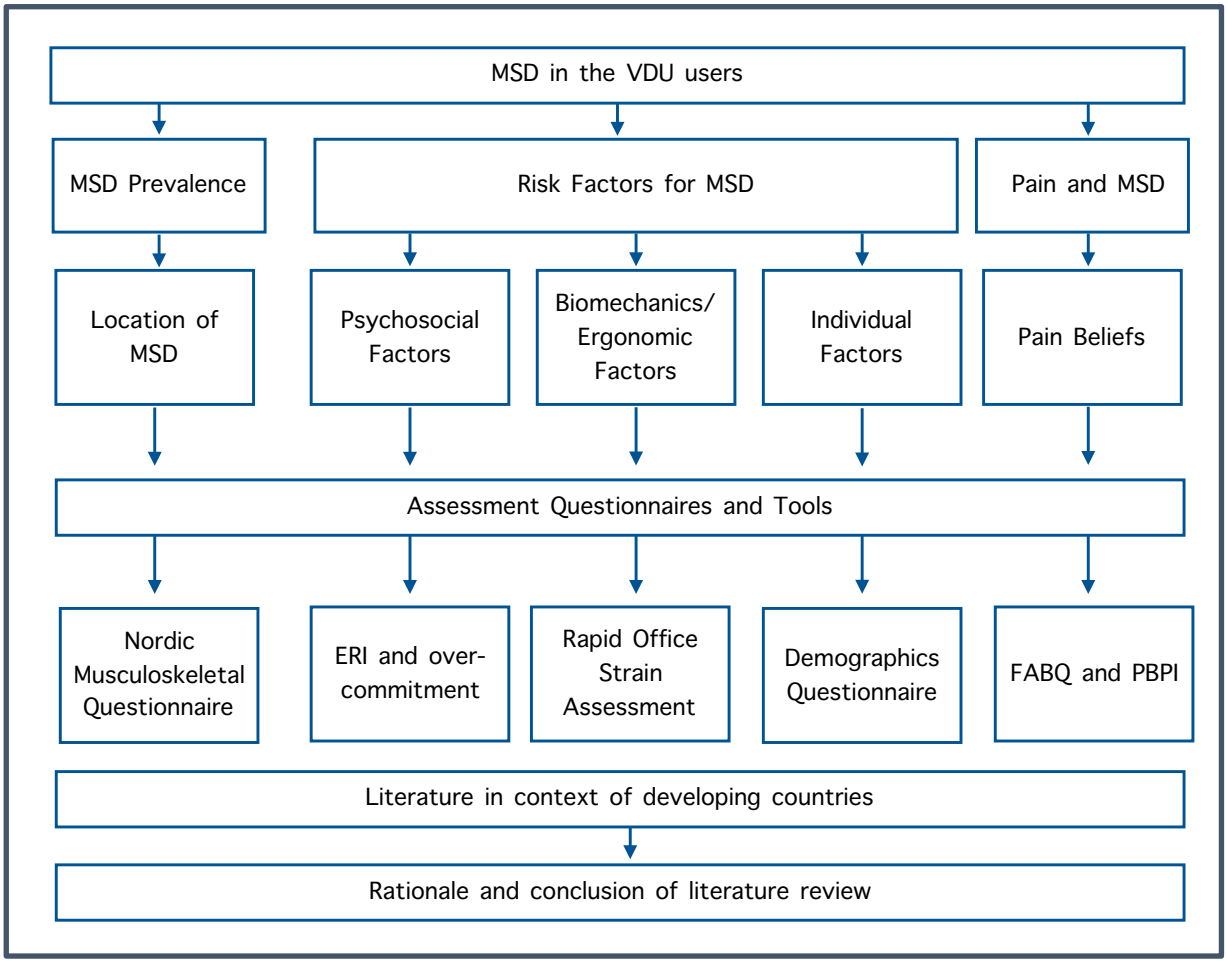


Figure 2. 1 Diagrammatic outline of the Literature Review

2.2 Visual Display Units and Work-related MSD

As VDUs become more indispensable in the work place, there has been a dynamic change in the worker's platform (Kaliniene *et al.*, 2013). As a result of the increase in VDU use in the work place, prevalence studies have been undertaken to better understand the impact of such a change.

2.2.1 Prevalence of MSD in VDU users

Work-related MSD continues to pose challenges to the health system (Silva *et al.*, 2014), and leads to disability, absenteeism, and compensation claims (Widanarko *et al.*, 2014; Maakip, Keegel and Oakman, 2017). When comparing developed and developing countries, there appear to be differences between prevalence rates and the site/location and the type of MSD observed. The reason for these differences may

be due to specific sociocultural factors (Maakip, Keegel and Oakman, 2017). The reported prevalence rate may also vary according to the type of occupation and the sample population studied (Huisstede *et al.*, 2006; De Cássia Pereira Fernandes *et al.*, 2016).

Studies report that VDU users experience as little as 2.3% (Huisstede *et al.*, 2006) and as high as 92.8% in self-reported rates of MSD (Maakip, Keegel and Oakman, 2016). Self-reported 12-month prevalence rates were found in the articles that were reviewed and documented, and the following studies presented with the highest and lowest rates per region: MSD of the neck - high at 68,2% (Mirzaei *et al.*, 2014) and low at 36.7% (Ranasinghe *et al.*, 2011); the shoulder region - high and low respectively at 65.27% (Mirzaei *et al.*, 2014) and 32% (Ranasinghe *et al.*, 2011); hands/wrists between 70% (Oha *et al.*, 2014) and 21% (Klussmann *et al.*, 2008); elbows - high at 15% (Klussmann *et al.*, 2008) and low at 7.7% (Piranveyseh *et al.*, 2016); lower back - high at 72% (Mirzaei *et al.*, 2014) and low at 6.6% (Wu *et al.*, 2012), upper back - high at 37.8% (Piranveyseh *et al.*, 2016), and low at 26.2% (Wu *et al.*, 2012).

Huisstede *et al,* (2006) suggested that the ambiguous classification and definition of MSD contribute to the extreme differences reflected in studies. There is a need for MSD to be classified and standardised both for research purposes and in practice (Huisstede *et al.*, 2006; Kraatz *et al.*, 2013). The difference in the percentages for prevalence may be due to factors related to the methodology. The systematic review by Huisstede *et al.,* (2006) involved 12 studies of various populations, including students, whereas all the other studies included only VDU users. The review reported on statistics from the 12-month cut-off point prevalence level to that of a lifetime.

Prevalence testing using the Nordic Musculoskeletal Questionnaire, is established by body region and requires recall for the previous 12 months, and the previous seven days (Kuorinka *et al.*, 1987). Only one of the studies used the Nordic Musculoskeletal Questionnaire in the original format; however, there was no mention of the time that the participants spent at their occupations (Mirzaei *et al.*, 2014). Two of the studies used amended Nordic Musculoskeletal Questionnaires, with Klussmann *et al.*, (2008) amending the time frame to also include a one-month prevalence cut-off point. Piranveyseh *et al.*, (2016) asked participants to indicate their experience of MSD for

only the previous three months prior to the completion of the questionnaire. Ranasinghe *et al.*, (2011) used another questionnaire in its complete detailed form, and the study by (Maakip, Keegel and Oakman, 2016) posed open-ended questions concerning MSD for the previous six months prior to the completion of the questionnaire. Variations in prevalence rates could be due to recall bias. Since the collection of data through interviews or self-administered questionnaires relies on accurate recall by the participants, this may be the reason why some of the researchers decided on other time lines (Piranveyseh *et al.*, 2016).

Inclusion criteria varies, with VDU use ranging from limited periods of one (Wu *et al.*, 2012) or two hours per day (Ranasinghe *et al.*, 2011) to no mention of any minimum inclusion hours (Klussmann *et al.*, 2008; Maakip, Keegel and Oakman, 2016). All the studies were cross-sectional in nature, and only Klussmann *et al.,* (2008) included the issue of a physical examination which it directed at only a portion of the participants.

As the time frame for data collection took as long as eight months in the study by Ranasinghe *et al.,* (2011), this could contribute to the findings as exposure to work demands and associated factors may be different at various times of the data collection phase and draw inaccurate conclusions. The risk factors for developing MSD were found to differ according to occupation and could be the reason for the vast differences observed between the values, since blue- and white-collar workers share the same risk factors, but also show specific differences in the risk factors for lumbar pain (Silva *et al.*, 2014). Depending on the aims of the study, a variety of questionnaires and methods were used to establish prevalence (Klussmann *et al.*, 2008; Das and Ghosh, 2010; Ranasinghe *et al.*, 2011; Shariat *et al.*, 2016).

The suggestion to confirm MSD with physical assessments/examinations could overcome the limitations mentioned above (Huisstede *et al.*, 2006; Klussmann *et al.*, 2008). However, this could result in another limitation, since the disclosure of MSD via anonymous questionnaires is less daunting than that of reporting it to the worker's supervisor (Maakip, Keegel and Oakman, 2016).

There is a need to establish more effective measures to study prevalence but this should be done without increasing the level of catastrophising amongst the participants. The lack of standardised time lines and methods of questioning draws the same limitations, namely; recall bias and disclosure concerns, varied population sample group, since the definition of work-related MSD's is inconsistent.

Keeping the limitations of prevalence studies in mind, some conclusions, based on supportive studies, can be drawn. Lower back pain has shown high prevalence rates in other studies for work-related MSD (Choobineh *et al.*, 2011; Mirzaei *et al.*, 2014; Abaraogu *et al.*, 2018). However, VDU users have shown increased upper quadrant prevalence rates in terms of lower back pain (Green, 2008; Das and Ghosh, 2010; Ranasinghe *et al.*, 2011; Wu *et al.*, 2012; Ardahan and Simsek, 2016). Specifically, disorders of the neck have been rated as the most common ailment in the upper quarter (Green, 2008; Wu *et al.*, 2012). Multi-site pain is also prevalent in VDU users (Oha *et al.*, 2014; Neupane and Nygård, 2017). The risk factors associated with MSD are discussed below.

2.2.2 Risk Factors for MSD in VDU Users

A recent review by Sun, Nimbarte and Motabar, (2017) indicated that the risk of MSD in workers can be increased merely through their exposure to the use of a VDU. The multi-factorial nature of MSD has resulted in studies investigating correlations, associations, as well as the combined effects of risk factors.

2.2.2.1 Combination of Physical and Psychosocial Factors

The risk of developing upper quadrant symptoms increases when participants are exposed to both physical and psychosocial factors (Devereux, Vlachonikolis and Buckle, 2002). The combination of physical and psychosocial risk factors increases the odds for MSD (Korhonen *et al.*, 2003; Widanarko *et al.*, 2015). Despite the fact that this was an old study, it was concluded that participants with high mental stress levels and limited physical exercise regimes had an especially high risk of developing MSD (Korhonen *et al.*, 2003). Furthermore, the interaction between the physical and psychosocial factors and the site/region of MSD were found to differ (Devereux, Vlachonikolis and Buckle, 2002). This difference could be due to the heterogeneous nature of the study sample, the limitations of self-administered questionnaires, and the data analysis method employed in this study (Devereux, Vlachonikolis and Buckle,

2002). Although studies contradict themselves as to which of the two domains, psychosocial or physical, contribute more to MSD (Canjuga, Läubli and Bauer, 2010; Mehta and Parijat, 2012), this could be due to the methodology, the sample population tested, or even the definitions of terms. The time lapse between the assessment of the working conditions and publishing of the results of the study by Devereux, Vlachonikolis and Buckle, (2002) begs the question as to the recommendation that MSD be managed merely by amending exposure to the use of a VDU is sufficient considering vast differences in working situations in 2019. However, this warrants further research into the specifics of each factor, as well as into the interaction between the relevant factors.

To foster a better understanding of the combination of risk factors, the following section discusses each risk factor and appraises the literature. The psychosocial factors are addressed first, and the physical and biomechanical factors follow after this section.

2.2.2.2 Psychosocial Factors and MSD in VDU Users

Work-related psychosocial risk factors are defined as an interplay between the social (environment) and the psychological (individual) characteristics that could affect the health, job satisfaction, effectiveness and the performance of workers (Lima and Coelho, 2018). Work-related psychosocial factors have also been defined as the perceptions or beliefs of the workers as to the way in which their work environment is organised (Mehta and Parijat, 2012). As this is a broad definition, only literature sources relevant to this study and defined by either work-related MSD or VDU, were included in this review.

There is a wide range of psychosocial factors, and also a wide variety of constructs. One such construct includes job demands. Job demands refer to the physical, psychological, social, and organisational aspects of the work that require physical and psychological efforts (Demerouti and Bakke, 2011). Another psychosocial factor includes the environmental factors pertaining to the work situation. The factors relating to the working environment include the ergonomic climate, the corporate culture, and the level of satisfaction with the design of the work place (Robertson, Huang and Lee, 2017).

A longitudinal study with a control group, the effects of addressing work-place design, as well as training to include corporate values, management support and responsiveness, resulted in improved work postures and reduced the risk for MSD (Robertson, Huang and Lee, 2017). Furthermore, the improvement in the individual's posture was found to be greater when the individual had a better perception of the corporate and ergonomic culture (Robertson, Huang and Lee, 2017). These authors inferred that this could be due to the fact that the intervention allowed the individuals to foster a sense of identity and ownership in terms of the organisation, as well as to promote open dialogue with management, which in turn allowed management to prioritise these issues (Robertson, Huang and Lee, 2017). This is a promising concept and intervention but certainly requires larger sample sizes and follow-up interventions over a longer period.

Various methods to assess psychosocial factors have been developed, and factors used in the Job Content Questionnaire include skills discretion, decision-making authority, psychological work demands, physical exertions, social support and co-worker support. The greatest predictor of MSD or discomfort was found to be co-worker support (Mehta and Parijat, 2012). This was in a small, young, predominantly male population group of VDU users, and as such, the results of the study should be extrapolated with caution.

Job content has been positively associated with MSD in a large sample group of VDU users in a number of companies (Riccò *et al.*, 2016). Job content had higher odds ratios specifically where a single task was most prevalent (Riccò *et al.*, 2016). The association between MSD and the role of single tasks in the job content of employees was supported by the study of VDU users by Collins and O'Sullivan (2015). The role of gender and age also affects the risk factor of with job content. However, both studies (Collins and O'Sullivan., 2015; Riccò *et al.*, 2016) point out that the job content variable is not associated with all MSD conditions, but specific to various sites/locations. Collins and O'Sullivan (2015) found that neck and shoulder pain was higher in females than males. Both studies involved large sample groups, and assessed physical and psychosocial factors, but owing to their cross-sectional nature, the results could not account for causation.

Work style, classified under working technique by Wahlstrom (2005), has also been included as a psychosocial factor, and includes a multi-dimensional concept to encompass behavioural, cognitive and physiological stress responses to work. Work style in VDU users has also been associated with upper quadrant pain in a changing work environment (Meijer, Sluiter and Frings-Dresen, 2008). Based on these findings, the reasoning, is that if a poor work style can be addressed earlier on, MSD could be prevented (Meijer, Sluiter and Frings-Dresen, 2008). However, this was a small sample group, the definition of the changing environment was not defined, and work style was assessed in only a 12-month follow-up period.

Organisational factors have been associated with MSD (Silva *et al.*, 2014; Widanarko *et al.*, 2015; Piranveyseh *et al.*, 2016; Lima and Coelho, 2018); however, on account of the fact that each study defined it differently, no conclusions could be drawn. In a study involving the majority of young male participants, the workers' perceptions towards the organisation significantly influenced the risk for shoulder MSD, but not neck, back, lower back or wrist disorders (Piranveyseh *et al.*, 2016). Standard definitions and assessments of what are considered to be organisational factors should be established to allow for comparative studies.

Emotional exhaustion and perceptions of limited job security are risk factors for MSD (Oha *et al.*, 2014). Although this study was done on a heterogeneous sample group, only psychological and physical demands were found to have an effect on neck and back pain; social support and job control did not (Canjuga, Läubli and Bauer, 2010). Autonomy as a psychosocial risk factor refers to the individual's participation in decision-making and determines his/her own task changes and the time and speed at which job tasks should be undertaken (Ranasinghe *et al.*, 2011). High demands, work overload, a lack of or minimal autonomy, and limited social support (both from colleagues and superiors) were found to be associated with MSD (Ranasinghe *et al.*, 2011). The above-mentioned psychosocial factors were also found to determine the severity of MSD (Ranasinghe *et al.,* 2011). This very fact provides a clue for a management strategy to mitigate the intensity of the psychosocial factors and hence influence the severity of MSD and potential disability. Limited social support, large psychological demands in terms of work, and limited control are high risk factors for neck symptoms in females (Wahlstedt *et al.*, 2010). Similarly, limited social support

and psychological factors (Driessen *et al.*, 2011), high work demands, changes to work methods, and an imposed work pace (Silva *et al.*, 2014) are also associated with lumbar pain. In a study conducted on blue-collared workers, high physical demands and limited job control were associated with elevated risks of neck, shoulder and wrist symptoms (Yu *et al.*, 2013).

Using the data concerning blue-collared workers should be approached tentatively, as those with higher education levels, namely the white-collared workers, tend to have higher levels of job control and autonomy (Piranveyseh *et al.*, 2016). More specifically, psychological demands were found to be significantly associated with upper quadrant MSD in a study of VDU users only (Coelho *et al.*, 2015).

Besides the study by Coelho *et al.*, (2015), many studies include heterogeneous samples (Canjuga, Läubli and Bauer, 2010; Wahlstedt *et al.*, 2010; Driessen *et al.*, 2011; Ranasinghe *et al.*, 2011; Yu *et al.,* 2013; Silva *et al.*, 2014) and these could skew the results. As observed in the previous studies, the various associations differ vastly in terms of the site/location of MSD. VDU users reported that greater volumes of office work, increased personal computer usage, and lower levels of job content were significant circumstances affecting workers suffering from neck and shoulder MSD (Collins and O'Sullivan, 2015).

Further statistical analysis could contribute to these findings, as age groupings and gender were also analysed. One could argue that, since the prevalence of MSD is higher in the neck and upper quadrant, VDU users have fewer physical demands made upon them, the latter being inconsequential in making them vulnerable to the threat of MSD. Psychological demands would then, most likely, tend to contribute more to MSD than physical demands. In order to establish true conclusions, perhaps clearer definitions and greater clarity on the exposure criteria are required (Devereux, Vlachonikolis and Buckle, 2002).

Contradictory to the above findings of an association between high work demands and the risk of MSD, a trend showing limited cognitive demands in terms of work was found to be associated with MSD symptoms (Collins and O'Sullivan, 2015). Perhaps a further

refinement of statistical analysis is needed, as well as access to better assessment tools, or longitudinal studies, to determine causation.

Dissatisfaction with the current job was not found to be associated with MSD (Riccò *et al.*, 2016). However, in more than one study (Klussmann *et al.*, 2008; Coelho *et al.*, 2015; Maakip, Keegel and Oakman, 2017) job dissatisfaction was found to be positively associated with or to pose a risk for MSD. Dissatisfaction could cover a multitude of psychosocial factors, and more specific assessments are necessary to establish the nature of these associations.

In an older study, the influence of psychosocial factors in the individual's private life that could affect work-related MSD, was not supported owing to a lack of sufficient evidence (Hoogendoorn *et al.*, 2000). Wahlstrom, (2005) also found studies for factors that influence MSD outside the working environment to be lacking. However, in a large-scale study, the authors discovered that participants were able to distinguish between work-related and other types of pain (Canjuga, Läubli and Bauer, 2010). Researchers should therefore devise tailor-made questionnaires to clarify the causes of work-related MSD, and then further investigate all personal social factors. The effect of personal social factors has been well established in a patient population suffering from chronic pain (Wijma *et al.*, 2016). Studies to assess both work-related psychosocial factors, personal factors and pain-related psychosocial factors have been conducted and interventions implemented (Myhre *et al.*, 2013; Oha *et al.*, 2014; Marchand *et al.*, 2015).

One such outcome measure in these chronic pain patients includes absenteeism. Absenteeism was not associated with MSD, and thus MSD is not considered a risk factor for absenteeism, but a mediating factor (Abdullah *et al.*, 2015). Although this was a small cross-sectional study, a larger study concluded that a combination of physical and psychosocial factors tend to increase the risk of absenteeism (Widanarko *et al.*, 2014). Although the majority of the participants were blue-collared workers in the above-mentioned study, physical factors were all associated with MSD, reduced activity and absenteeism. This could be explained by the Fear Avoidance Belief Model, where altered pain beliefs perpetuate pain, increase absenteeism and time away from work (Marchand *et al.*, 2015). This aspect is discussed later in the literature review. At

this stage, however, the roles of physical loads and biomechanical and work-station ergonomics in MSD are addressed.

2.2.2.3 Physical Loads and MSD in VDU Users

The literature is rich in examples of work-related MSD being influenced by work-related physical factors/load (Wahlstrom, 2005; Das and Ghosh, 2010; Wu *et al.*, 2012; Kaliniene *et al.*, 2013). Physical load refers to forces produced biomechanically by the body (Wahlstrom 2005). The load on the biomechanical system is suspected to cause tissue damage and inflammation, thus resulting in the MSD condition (Bruno Garza and Young, 2015). The physical factors include muscular load, non-neutral postures/extreme postures, force, repetitive tasks, and low static contractures (Wahlstrom, 2005; Das and Ghosh, 2010; Ranasinghe *et al.*, 2011; Bruno Garza and Young, 2015; Sun, Nimbarte and Motabar, 2017). Physical load in the VDU user falls outside the scope of this study. However, some of these details will be discussed next in the literature review under the biomechanics and work-station ergonomics section.

2.2.2.4 Biomechanics and VDU Work-station Ergonomics

An unsatisfactory ergonomic work-station set up has been shown to increase muscular load and activity, thus causing increases in the prevalence of MSD (Wahlstrom, 2005; Sun, Nimbarte and Motabar, 2017). Daily computer usage is considered a risk (Das and Ghosh, 2010; Ranasinghe *et al.*, 2011; Wu *et al.*, 2012; Ardahan and Simsek, 2016), while increasing the time period spent at the VDU per day also increases the risk of MSD (Das and Ghosh, 2010; Wærsted, Hanvold and Veiersted, 2010; Wu *et al.*, 2012; Chaiklieng and Krusun, 2015; Piranveyseh *et al.*, 2016). Furthermore, a lack of breaks when working (Kaliniene *et al.*, 2013; Ardahan and Simsek, 2016; Celik *et al.*, 2018), years of computer usage (Basu, Dasgupta and Ghosal, 2014; Ardahan and Simsek, 2016; Ye *et al.*, 2017; Celik *et al.*, 2018), an awkward body posture (Lis *et al.*, 2007; Celik *et al.*, 2018), incorrect computer positioning, holding both forearms above the level of the desk (Celik *et al.*, 2018), a lack of forearm support (Leyshon *et al.*, 2010; Wærsted, Hanvold and Veiersted, 2010; Van Eerd *et al.*, 2016), bad work habits (Wærsted, Hanvold and Veiersted, 2010; Ranasinghe *et al.*, 2011; Wu *et al.*, 2012; Sun, Nimbarte and Motabar, 2017), a lack of document holders (Coelho *et al.*, 2015), the experience of physical discomfort (Ardahan and Simsek, 2016), an off-centre monitor (Sun, Nimbarte and Motabar, 2017), laptop devices (Asundi *et al.*, 2012; Saied,

Kamel and Mahfouz, 2013; Werth and Babski-Reeves, 2014), increased hours of mouse work and keyboard use (Wærsted, Hanvold and Veiersted, 2010), the positioning of the mouse some distance from the keyboard (Celik *et al.*, 2018), the sitting position, and the duration of this pose (Green, 2008; Silva *et al.*, 2014; Celik *et al.*, 2018) have all been linked with an increased risk for MSD.

A poor ergonomic work-station set-up has been shown to increase muscular load and activity causing increases in MSD (Wahlstrom, 2005; Sun, Nimbarte and Motabar, 2017). With regard to the work-station set up, the comprehensive review conducted by Woo, White and Lai (2016), included standards from all across the world, as well as various guidelines regarding the work-station arrangement.

Woo, White and Lai, (2016) note that the studies use a baseline of anthropometrics and biomechanics to establish guidelines for computer work-station design. However, with the differences in anthropometrics in each country, guidelines should be flexible for each end user. The South African National Defence Force is the custodian of the South African anthropometric database. The review by Woo, White and Lai, (2016) does not cover any African, let alone South African guidelines/studies. There is a need, therefore, to research the South African population anthropometrics within the work-station design framework in order to establish South African guidelines.

A limitation to any guideline is the implementation of the guidelines, and Woo, White and Lai, (2016) discovered that the guidelines are variable and not always enforced. Riccò *et al*., (2016) also found a lack of adherence to the guidelines, and as a result, a higher level of associated MSD in those participants accessing a work-station design that was not optimally ergonomic. This was supported by a study where the Rapid Upper Limb Assessment (RULA) found positive associations between the probability of neck MSD and a higher risk score with RULA (Kaliniene *et al.*, 2013).

Quantifying the ergonomic risk of a work station is a method to cost-effectively implement and manage MSD in the work place (Sonne, Villalta and Andrews, 2012). As found by various authors (Ardahan and Simsek, 2016; Robertson, Huang and Lee, 2017), some VDU users have a poor knowledge of ergonomic principles, thus increasing the risk for MSD. This may mean that baseline assessments of end users' knowledge may be needed to devise tailor-made intervention programmes.

As a result of their compact design and due to altered biomechanics, which do not always conform to the recommended guidelines, laptop devices pose a higher risk for users to develop MSD than traditional desktops (Werth and Babski-Reeves, 2014). As opposed to desktops, laptops also increase muscular load and result in non-neutral postures (Asundi *et al.*, 2012; Saied, Kamel and Mahfouz, 2013; Werth and Babski-Reeves, 2014). With the added risk of laptops for MSD, the use of laptops for a shorter period of time has been recommended (Saied, Kamel and Mahfouz, 2013). Static, prolonged and constrained postures have been associated with MSD in VDU users (Das and Ghosh, 2010) and may also have compounding effects on MSD on account of other risk factors such as the laptop risks mentioned by Saied, Kamel and Mahfouz (2013) and the nature of the VDU work requirements.

Das and Ghosh (2010) quantified that periods of more than four to six hours on VDUs would result in maximum discomfort. Using a desktop for more than four hours a day was found to present a high risk for work-related shoulder pain (Chaiklieng and Krusun, 2015). Another study found that as limited a period as two hours a day on the computer can be considered to be a risk factor (Wærsted, Hanvold and Veiersted, 2010). Yet, a cross-sectional study in a developing country found no association between the time spent working on the computer and MSD (Kaliniene *et al.*, 2013). However, a lack of breaks in the working day was found to increase the risk for MSD (Kaliniene *et al.*, 2013; Ardahan and Simsek, 2016; Celik *et al.*, 2018). Using a computer for more than 15 years increases the risk for upper quadrant pain (Ardahan and Simsek, 2016). This could explain the association of MSD with age/years working (Basu, Dasgupta and Ghosal, 2014; Celik *et al.*, 2018).

The lack of any experience of physical discomfort, poor ergonomics information (Ardahan and Simsek, 2016), and the belief that MSD is caused by conditions in the work place are considered to be risk factors for MSD (Oha *et al.*, 2014). On account of the multiple work-station risk factors, as mentioned above, a plausible deduction would seemingly be to address the ergonomic work-station set up as a method to prevent, as well as address, MSD (Ranasinghe *et al.*, 2011). However, there is still conflicting evidence that shows no correlation between work-station set up and MSD (Klussmann *et al.*, 2008; Wu *et al.*, 2012; Coelho *et al.*, 2015; Lima and Coelho, 2018). These studies were all on a small scale, and all used various methods to assess work-station ergonomics. Standardised tools for risk assessment, with the addition of time

increments, should be developed since conclusions have already been drawn on the tools devised through research that could influence the quality and reproducibility of the research. In fact, Chaiklieng and Krusun (2015) have made strides in this respect in presenting a self-devised risk assessment tool.

There is moderate evidence to support interventions to redesign ergonomic work stations to improve comfort (Leyshon *et al.*, 2010), but insufficient evidence to support ergonomic chairs, lumbar support, alternating mouse use and downward-tilting keyboards (Leyshon *et al.*, 2010). The recent study by Ye *et al.*, (2017) found that an off-centre monitor and more than five years of working at the VDU are associated with non-specific neck and back pain. However, no mention was made in the study of the monitor height, or even the demands placed on the user by the circumstances at the work place.

To the author's knowledge, there has been only one study conducted in South Africa. This was a case study, and although pain and discomfort were found to decrease with an optimal ergonomic work-station set up, no other psychosocial factors were taken into account (van Vledder and Louw, 2015). In order to implement more effective prevention programmes, and to address all the psychosocial factors influencing MSD, there is a need for a standardised assessment and outcome measure (Macdonald and Oakman, 2015).

As previously described, biomechanics and anthropometry are baselines for ergonomic guidelines, but these aspects do not consider the dynamic nature of sitting (Woo, White and Lai, 2016). Owing to the many demands of the work station and user, work-station designs and guidelines have resulted in adjustable furniture options being made available to the user. However, many users do not know how to adjust the work station nor furniture according to these guidelines (Woo, White and Lai, 2016). Education and training are required to allow adaptations to the task and the person. Although the guidelines are available, further research is needed to remain up-to-date with the current findings regarding the work place and the associated dynamic changes in it (Woo, White and Lai, 2016).

In the review by Woo, White and Lai, (2016) a variety of work station ergonomic standards was noted. The general aim of the standard is to minimise the physical risk factors. Some standards suggest specific guidelines, including a neutral posture, an

optimal distance from the screen, the use of supportive accessories, the correct type of chair and a satisfactory sitting position (Lima and Coelho, 2018). These ergonomic guidelines are often based on minimising the risk factors for MSD. Further discussion on these risk factors now follows.

Non-neutral postures have been associated with MSD (Wahlstrom, 2005; Das and Ghosh, 2010; Ranasinghe *et al.*, 2011; Bruno Garza and Young, 2015; Sun, Nimbarte and Motabar, 2017). The correlation of neck pain, disability and forward head posture has been established (Kim and Kim, 2016), and could be indicative of the effect of non-neutral postures. A constant neck flexion angle and holding the neck in a bent position has also been determined as a risk factor among VDU users for MSD in the neck (Wu *et al.*, 2012; Sun, Nimbarte and Motabar, 2017). Furthermore, a poor ergonomic work-station set up tends to increase muscle activity around the neck and shoulder muscles (Sun, Nimbarte and Motabar, 2017). A neck flexion angle of 45 degrees has been found to significantly affect pain in the upper and lower back, shoulders, and feet (Celik *et al.*, 2018). As seen in a small sample group (Werth and Babski-Reeves, 2014), the use of laptops increases neck flexion angles and limits the adjustability of the work station. This could affect work postures, bringing about discomfort and MSD.

Through an EMG assessment of a small group of male participants, continuous computer work was found to change the scapula position. This means that postural education may need to include the neck, thoracic and scapula regions (Park and Yoo, 2013). Considering the above, postural correction interventions seem plausible.

Input devices are defined as keyboards and mice. There appears to be evidence to the effect that increased hours of mouse work and keyboard use increase the risk of MSD in the upper quadrant (Wærsted, Hanvold and Veiersted, 2010). The review by Bruno Garza and Young (2015) investigated alternative keyboards, mice, track balls, vertical mice, touch pads and roller bars. These alternative options showed fewer non-neutral postures and less muscle activity. However, the findings were inconclusive and it could not be determined whether any of these alternatives were better than the conventional options (Bruno Garza and Young, 2015). The review by Leyshon *et al.,* (2010) explored the effect of interventions for MSD management in terms of safety, productivity and comfort. Leyshon *et al.*, (2010), as well as Bruno Garza and Young (2015) also showed inconclusive evidence for efficacy of alternative ergonomic solutions. Woo, White and

Lai, (2016) stated that the balance between managing the risk factors and respecting the comfort of the end user, does make interventions difficult. Having the position of a mouse a distance from the keyboard was found to have a significant effect on pain in the upper quadrant (Celik *et al.*, 2018). This same self-reported study found that mouse use was independently associated with lower back pain in males (Celik et al. 2018). This could be due to non-neutral postures or to the static holds required in completing the task.

It is a fact applying to the general population at large that occupations requiring sitting for most of the day increase the prevalence of lumbar pain, (Lis *et al.*, 2007). The authors did acknowledge, however, that physical, psychosocial and individual factors also contribute to this finding (Lis *et al.*, 2007). Sitting is a risk factor for lower back pain and other MSDs (Green, 2008; Silva *et al.*, 2014; Celik *et al.*, 2018), and sitting for long periods increases the risk for lower back pain (Silva *et al.,* 2014). Biomechanically, pain in the lumbar region associated with sitting has been explained by the theory that in sitting lumbar flexion increases pressure on the discs and posterior structures, thus causing lumbar MSD (Kim *et al.*, 2014). As a result of the flexion risk, alternative sitting postures have been investigated. Hence, the concept to minimise lumbar flexion and reduce strain through sloped sitting was investigated (Kim *et al.*, 2014; Hamaoui, Hassa and Zanone, 2015). On biomechanical assessment, sloped sitting reduces the lumbar flexion (Kim *et al.,* 2014). In a small EMG-based study, however, researchers found no benefit to the postural chain with sloped sitting (Hassaine, Hamaoui and Zanone, 2015). There was, however, evidence of increased lower limb muscle activation and an altered trunk motor pattern. As such, sloped sitting cannot be used as a method to improve posture (Hamaoui, Hassa and Zanone, 2015). These findings require more robust research, larger samples, and the consideration of other outcome measures before conclusions can be drawn regarding the management of MSD. In an asymptomatic group of participants, various sitting postures were analysed. In this study sample of only 20, the sitting posture with the most neutral neck and head alignment and the least extensor activity was found to be in the lumbo-pelvic posture. This was defined as a neutral lumbar lordosis and a relaxed thoracic spine. Slumped sitting was found to be accompanied by a high level of muscular activity in the neck and thoracic region (Caneiro *et al.*, 2010). Alternatives to sitting and working with a VDU include standing desks, or sit-stand work stations. However sitting alone

cannot be considered to be a risk factor, unless it is considered in association with other risk factors (Lis *et al.*, 2007). Sitting for long periods of time has been described as a constraining condition by workers, and hence requires some attention (Silva *et al.,* 2014). The movement attained in sit-stand desks may result in an offloading of the soft tissue structures (Le and Marras, 2016). The study by Nevala and Choi, (2013) found that a combination of sitting and standing tends to reduce the strain in the upper limbs, and to bring about increased productivity. This is contradictory to the later study by Riccò *et al.*, (2016), which found no significant differences for sit-stand work stations. This may be due to the small study sample and the duration factor which may have caused the results in Nevala and Choi (2013) to vary from those in the study by Riccò *et al.,* (2016). As Riccò *et al.,* (2016) state, there has been a gradual decline in the use of and compliance with the sit-stand regime over time.

Comparisons of the amount of motion in a lumbar segment and intensity of load in the lumbar spine have been conducted in the sitting, perching and standing positions (Le and Marras, 2016). Although this was a small study conducted within a short time framework, the greatest movement was observed in the standing, and then in the perching and finally sitting positions. The highest lumbar sheer was observed in the standing position. Although not sufficiently above the threshold, however, the sheer could be accumulative in nature. In terms of discomfort, the participants found greatest comfort in sitting (Le and Marras, 2016). The dilemma is to find a balance between movement, load, comfort and productivity and in the management of all of the known risk factors. Owing to the changing demands of the work requirements, dual monitors have become common. Although for a small sample of only 15 participants, the researchers recommended, amongst others, that a single monitor should be positioned directly in front of the user, and that dual monitors should be placed at 150 degrees to pose a minimal risk for MSD (Estember, Panugot and Vale, 2015). The work-station recommendations regarding the monitor placements that have been made were in order to accommodate the requirements of the task such as typing, searching, finding and reading (Estember, Panugot and Vale, 2015). These should also be included in the proposed guidelines.

Although biomechanics and psychosocial factors clearly play a role in this multi-factorial problem, the individual is also faced with a number of associated risk factors, which are discussed below.

2.2.2.5 Individual Factors and MSD in VDU Users

Individual factors such as age (Mehta and Parijat, 2012; Wu *et al.*, 2012; Oha *et al.*, 2014; Riccò *et al.*, 2016), educational level (Wu *et al.*, 2012), home situation (Wu *et al.*, 2012), smoking status (Wu *et al.*, 2012; Korhonen *et al.*, 2013), working age (Korhonen *et al.*, 2003; Riccò *et al.*, 2016), participation in leisure-time activities (Abdullah *et al.*, 2015), a lack of physical activity (Korhonen *et al.*, 2003; Riccò *et al.*, 2016; Celik *et al.*, 2018), body mass index (BMI) (Kaliniene *et al.*, 2013), existing health problems/co-morbidities (Mehta and Parijat, 2012; Kaliniene *et al.*, 2013; Baek, Kim and Yi, 2015), previous injury to the neck (Abdullah *et al.*, 2015; Ye *et al.*, 2017), previous injury to the back area (Ye *et al.*, 2017), marital status (Ye *et al.*, 2017; Celik *et al.*, 2018), and family members with work-related MSD (Abdullah *et al.*, 2015), are all recognised risk factors for MSD or tend to influence the vulnerability of a worker to suffer from MSD.

Like depression/anxiety, general fatigue, previous injury by accident, and sleep disorders, individual co-morbidities are also associated with increased reports of MSD (Baek, Kim and Yi, 2015). This cross-sectional study was not specific to VDU users, but to a working population. The suggestion to reduce the number of working hours, to realistically address deadlines and to improve job satisfaction as a prevention method (Baek, Kim and Yi, 2015) would need prospective studies and more vigorous research. The participants who had sustained injuries in accidents, who had been in surgery and who had family members with work-related MSD added to the numbers experiencing neck MSD (Abdullah *et al.*, 2015). In a large study, a lack of physical exercise increased the odds ratio for MSD by 2.758. This was specific to VDU users, and a large sample population (Riccò *et al.*, 2016).

An increase in age is considered a risk factor on account of the normal changes that happen with aging. Although a small study, the prevalence for discomfort in the VDT group studied (Das and Ghosh, 2010) increased with age above 40 years, regardless of sex. In a five-year longitudinal study, age was considered to be a risk factor for neck pain in a large study of VDU users (Korhonen *et al.,* 2003), as well as a risk factor for developing two MSD sites of pain. Furthermore, age was found to be a risk factor for a linear increase in MSD with increased age (Herin *et al.*, 2014). However, age was not found to be related to MSD in VDU users in a study through self-reported methods by Ardahan and Simsek (2016). Neither was this association found to prevail in the

large-scale study by Collins and O'Sullivan (2015). The aforementioned study only found associations between age and knee-related MSD, but also mentioned that age groups classified in terms of the sex variable were not found to be a risk factor in MSD.

Studies generally tend to adjust for age in the statistical analysis of the research data, but although the age variable is recorded, these same studies do not discuss in their findings the specifics of the age variable (Wu *et al.*, 2012; Widanarko *et al.*, 2015; Maakip, Keegel and Oakman, 2016). As such, there appears to be conflicting evidence for age as a risk factor for MSD.

Sex also brings with it its own risk factors, where female prevalence of MSD has been found to be higher than in the male counterparts (Klussmann *et al.*, 2008; Das and Ghosh, 2010; Wahlstedt *et al.*, 2010). However, this finding has also been contradicted (Ardahan and Simsek, 2016). Gender and years in the occupation increase the odds for neck and shoulder MSD, and shoulder, elbow/forearm MSD respectively (Klussmann *et al.*, 2008). Sex is considered a risk factor on its own (Green, 2008; Mehta and Parijat, 2012; Wu *et al.*, 2012; Ardahan and Simsek, 2016). Korhonen *et al.,* (2003) found that females have a high risk factor for neck pain. This finding has been supported by Wu *et al.,* (2012) and Klussman *et al*., (2008). Females are also significant in contributing to specific ergonomic risks such as mouse use since they generally experience greater muscle load increases and forces than men (Korhonen *et al.,* 2003). Males using a computer for more than seven hours per day, and for three consecutive hours, without taking any break, constitute an increased risk factor for multi-site MSD (Ardahan and Simsek, 2016). Physical and psychological work-related factors for a five-year incidence of MSD may be sex specific (Herin *et al.*, 2014). Psychological factors are predictive of the onset of MSD, but only in woman, whereas physical work factors are predictive of MSD in men (Herin *et al.*, 2014). One study found that sex differences prevail in psychosocial risk factors and MSD (Collins and O'Sullivan, 2015). Gender is considered to play a 13% contributory role in a predictive risk model for MSD (Maakip, Keegel and Oakman, 2016). Gender also appears to play a part in the risk for MSD, and this could be due to the different biological physiologies of the sexes, the influences on gender roles, and the increased risks associated with psychosocial factors (Maakip, Keegel and Oakman, 2016).

The complexity of the risk factors not only lies within the broad scope of each risk factor, as described above, but also within the ever-fluid interplay between each construct, namely the psychosocial, biomechanical/ergonomic and the individual categories, as unfolded in the next section, which deals with the effects of stress and how these affect MSD.

2.2.2.6 Stress and MSD in the VDU User

The role of stress in causing MSD can be explained in terms of three theories which elaborate on the following effects: namely, a physiological response including muscle tension as a defence mechanism; secondly, a neuromuscular mechanism, and finally, the overuse of the low threshold muscle units, thus affecting the blood supply and limiting healing and repair, or a combination of the above (Widanarko *et al.*, 2014).

Stress can also affect one's psychological mood and behaviour (Widanarko *et al.*, 2014). There seems to be consensus in the literature as to how psychological strain causes lower tolerance levels for other factors and results in increased reporting of MSD (Hoogendoorn *et al.*, 2000; Widanarko *et al.*, 2014; Bonzini *et al.*, 2015). The opposite has also been suggested where MSD can affect stress levels (Bonzini *et al.*, 2015).

Work overload includes factors such as the need to work quickly in order to complete tasks on time, difficult tasks, and too many tasks to complete (Ranasinghe *et al.*, 2011). In their study, Ranasinghe *et al.* (2011) found a 1.11-1.56 increased odds ratio for MSD. This could be due to the effects of stress on MSD, and demonstrates how an excessive work load could establish a stress response.

Further to this, the review by Hoogendoorn *et al.*, (2000) investigated how psychosocial stress influences biomechanics through posture, movement and forces, but also causes muscle tension and hormonal changes. Over time, these hormonal changes can influence pain perceptions and in turn affect symptoms (Hoogendoorn *et al.*, 2000).

The consequential relationship between stress and pain is poorly understood (Hoogendoorn *et al.*, 2000). More recent studies have found promising correlations between the influence of psychosocial factors, mental stress and MSD in the work

place (Wahlstrom, 2005; Kaliniene *et al.*, 2013; Widanarko *et al.*, 2015). One could deduce that there are correlations between stress and MSD that are based on the physiological and psychological findings mentioned above.

Work stress has been associated with neck and lumbar symptoms (Widanarko *et al.*, 2014), as well as MSD in the entire body (Celik *et al.*, 2018). Both studies were cross-sectional, and data collection was conducted by means of questionnaires, so causality cannot be established. However, a five-year longitudinal study discovered that the perception of stress at baseline results in a small increased risk of MSD, but that MSD at baseline is substantially associated with new stress at follow up (Bonzini *et al.*, 2015). This study was conducted on nurses and used a different questionnaire from the ones for the above-mentioned studies. As such, the relationship between stress and MSD as a predictive risk factor is not perfectly understood (Bonzini *et al.*, 2015).

This unclear relationship between stress and MSD was also reported by Choi, Jang, Lee, Kim, Park and Han (2018). The study of a large sample group of VDU users and a control group found no significant differences between stress and pain in the lower quadrant (Choi *et al.*, 2018). However, increased job stress and a low quality of life were found to be directionally proportionate regardless of the presence of lower limb pain (Choi *et al.*, 2018). As pain significantly impacts upon the quality of life (Jonsdottir *et al.*, 2014), further research into quality-of-life factors in VDU users and efforts to address the effectiveness and quality of management of occupational health may be warranted.

The complexity of stress is beyond the scope of this study. However, the effects of stress on MSD and the link between psychosocial factors have resulted in a concept geared to the assessment of adverse health effects emanating from stress. This is the Effort-Reward Imbalance Model and is discussed in detail below.

2.2.3 Effort-Reward Imbalance Model and Over-commitment

As elaborated previously, psychosocial factors influence MSD (Wahlstrom, 2005; Kaliniene *et al.*, 2013; Widanarko *et al.*, 2014, 2015). The Effort-Reward Imbalance and Over-commitment Questionnaire was designed to clarify the impact of social and psychosocial factors on health and disease (Siegrist, 1996). These include the work

environment, as well as the attributes or character traits of the person (Siegrist, 1996). An extended period of strain causes the risk for illness, in that the self-regulation mechanisms are impaired (Siegrist *et al.*, 2004). This concept is supported in a similar model under the same premise of job strain (Kraatz *et al.*, 2013). The Effort-Reward Imbalance and Over-commitment Questionnaire is a legitimate tool to assess psychosocial stress in the workplace (De Jonge *et al.*, 2008), and is also considered to be a stress model to measure psychosocial factors in the working world (Koch *et al.,* 2014).

The effort component measures the work requirements, as dictated contractually (Siegrist, 1996), and also quantitative load, qualitative load and increased total load over time (Siegrist *et al.*, 2004). Quantitative load refers to the intensity of work and time demands (da Silva Bertolaccini and Nakajima, 2016), whereas qualitative demands are defined as conflicting demands, the interruption of tasks and concentration for long periods of time (Hoogendoorn *et al.*, 2000). A higher score indicates a higher perception of demands.

The reward is the reciprocation of such effort. In this case, rewards could be in the form of esteem, promotion and security (Siegrist, Li and Montano, 2014). This could be classified as the situation-specific component (Van Vegchel *et al.*, 2005).

An Effort-Reward Ratio is used to assess potential imbalances. A significantly high effort and limited rewards would produce a ratio of more than 1.0 (>1.0), also defined as non-reciprocity, while a limited effort and a high reward level would be defined as a ratio of less than 1.0 (<1,0) (Siegrist, 2012).

Over-commitment measures the work-related commitment, which could be elevated in those who have a misconception of perceived demands, as well as poor personal coping strategies (Siegrist, 2012). Over-commitment could be defined as a person-specific component (Van Vegchel *et al.*, 2005). Individuals in this category tend to have a distorted perception that hinders them from objectively assessing their own cost-gain relations (Siegrist, 1996). Over-commitment also applies to those who have a motivational pattern for excessive work-related commitment, as well as an extreme need for approval, and this increases their risk for a high Effort-Reward Ratio, non-

reciprocity (Siegrist *et al.*, 2004). Over-commitment is an assessment of the individual's personal coping attributes, and is sensitive over time (Siegrist *et al.*, 2004).

The links between the effort-reward imbalance, psychobiological mechanisms and adverse health effects have been successfully studied (Siegrist, 2012). A comprehensive review noted that a large Effort-Reward Ratio - non-reciprocity - are linked to an increased risk of psychosomatic symptoms (Van Vegchel *et al.,* 2005). The review specifically addressed the respective correlations between an effort-reward imbalance and over-commitment and MSD, and found moderate evidence for respective associations between a large Effort-Reward Ratio - non-reciprocity - and MSD; conflicting evidence for extreme over-commitment and MSD; and inconclusive evidence for a large Effort-Reward imbalance - non-reciprocity - and extreme over-commitment as a combined construct and MSD in an heterogenous group population (Koch *et al.*, 2014). These findings may be due to the quality of the studies reviewed, and the associated methodology.

In blue-collared workers, a positive association between over-commitment and MSD was found (Yu *et al.*, 2013). The deduction made was that the amount of influence that psychological demands, effort and over-commitment have on MSD tends to increase as the symptomatic areas increase (Yu *et al.*, 2013). This can be attributed to an accumulation of stress at work, or that MSD increases the perceptions of stress (Yu *et al.*, 2013). It may be valuable to add that over-commitment was also found to be significantly associated with fear-avoidance beliefs about work (Myhre *et al.*, 2013).

The authors found that when assessing the risk for MSD, extreme over-commitment tends to result in stronger associations with all of the models, job strain, iso-strain and the effort-reward imbalance (Lee *et al.*, 2014). Contradictory to other studies, a large Effort-Reward Ratio, - non-reciprocity - independent of extreme over-commitment, showed a higher risk association with MSD than over-commitment in conjunction with the Effort-Reward Imbalance Model and the above-mentioned models (Lee *et al.*, 2014). This could be on account of the population selected as the sample group, where the reward constructs (esteem, promotion, job security) for the ICU nurses may have been limited. The value of over-commitment in risk assessment seems highly relevant

as it is easily associated with other models. This may be due to its ability to assess intrinsic person-specific components.

The Effort-Reward Imbalance Model has been used to assess and implement interventions to manage associated stress and promote health. This could be done at both a personal level and a corporate level. The interventions on a personal level should include initiatives to address cognitions, attitudes and work-related motivations, as well as relaxation techniques. Corporate interventions include upskilling the supervisors, addressing esteem and recognition, making compensation for performance and job security, to name but a few (Siegrist, 2012). By addressing these factors, economic stability, as well as individual health outcomes, could be influenced over time (Siegrist, 2012).

One of the positive aspects of the Effort-Reward Imbalance Model is that it covers both structural components, as well as personal aspects. This increases its predictive power (Siegrist *et al.*, 2004). Unlike other assessments, that consider the specific work place, the Effort-Reward Imbalance Model is more indicative of economic labour market conditions. The use of this standardised questionnaire was found to accurately assess imbalances, that would have been missed if the participants had been questioned directly (Siegrist *et al.,* 2004).

Although the study by Siegrist *et al.,* (2004) was conducted in a heterogeneous professional group, and numerous countries were compared, the study showed that the Effort-Reward Imbalance Model can be used for both men and women. In the same study, a large Effort-Reward Ratio - non-reciprocity - and over-commitment were associated with poor self-rated health assessments. This notion is also supported by Feldt, Huhtala, Kinnunen, Hyvönen, Mäkikangas and Sonnentag, (2013) to the effect that over-commitment and non-reciprocity in terms of effort and reward are associated with stress symptoms, including burn out.

A positive association between fatigue and the effort-reward imbalance was observed (Takaki *et al.*, 2006). Those with an extreme tendency to over-commitment were found to be associated with larger Effort-Reward Ratio - non-reciprocity - and increased fatigue. Although this was a small study evaluating overtime workers (Takaki *et al.*,

2006), where fatigue may be common, it does indeed indicate that since over-commitment is intrinsic, the individual would feel the increased fatigue over and above other employees in the same situation when suffering more from a sense of over-commitment.

The need to have sufficient time off from work, for detachment, relaxation and a feeling of being in control of their lives is important for workers in order for them to recover from the huge demands placed upon them and the efforts required of them by their employers (Feldt *et al.*, 2013). Another study, found that by increasing the reward component with monetary rewards, there was less physiological strain on the workers. Cognisance should, however, be taken of the fact that subjective strain would still need to be assessed. As such, the study design suggests that the aforementioned conclusion should be drawn cautiously (Landolt *et al.*, 2017).

It has been suggested that those with higher levels of over-commitment should find it more difficult to separate themselves from their work, thus making relaxation difficult (Feldt *et al.,* 2013). In their review of 45 studies, Van Vegchel *et al.,* (2005), found that extremely over-committed employees were 1.92-5.92 times more likely to be at risk to present with a variety of psychosomatic symptoms, as opposed to employees with a low level of commitment. Unlike a large Effort-Reward Ratio - non-reciprocity - a high level of over-commitment is a risk for all health outcomes (Van Vegchel *et al.*, 2005). This implies that any intensified feelings of over-commitment could bring out anything from MSD to depression in an employee (Van Vegchel *et al.,* 2005). However, in a large-scale study, over-commitment did not affect the association between the Effort-Reward Ratio and MSD (Lapointe *et al.*, 2013). This could be skewed on account of the gap in follow-up in the longitudinal study and the recall bias for MSD.

There seems to be a gap between the Effort-Reward Ratio and over-commitment, as well as in the manner in which the components interact, complement and affect each other. This is explained in the review by Van Vegchel *et al*., (2005) as over-commitment could be considered a result or an effect of an Effort-Reward Ratio, or alternatively, over-commitment could be a long-term prediction of relevant symptoms. The cause-effect relationship between the constructs has been critiqued and remains an unsubstantiated aspect of the model (Van Vegchel *et al.*, 2005).

The role of compounding risk factors is well known, and in the longitudinal study of VDU users, the risk for MSD increases when both a large Effort-Reward Ratio - non-reciprocity - and increased ergonomic risk factors appear simultaneously (Lapointe *et al.*, 2013). This is more prevalent in women. However, the study implies that half of the population sample that developed MSD could have been prevented had the large Effort-Reward Ratio - non-reciprocity - been addressed or the ergonomic risk factors corrected (Lapointe *et al.*, 2013). This, however, was not seen in the male population studied and it could be that men and women respond differently to the Effort-Reward Imbalance Model (Lapointe *et al.*, 2013). There was a large gap in the follow up and recall bias for MSD which could have altered the results, but such a large decline in MSD is promising to note, and assessment studies of the effect of such interventions on MSD should be undertaken.

In an attempt to account for ergonomic risk factors, a study found that a large Effort-Reward Ratio - non-reciprocity - resulted in a positive relationship, with increases in pain in the right upper extremity (Krause, Burgel and Rempel, 2010). No other significant findings were noted in the rest of the upper quadrant. This could be due to the population sample using mainly the right hand to complete tasks (Krause, Burgel and Rempel, 2010). Although over-commitment as such was not researched, the authors suggested that with the statistical adjustments made, the effects on MSD, as defined by the Effort-Reward Imbalance Model, could be considered to be related to working conditions, and not to intrinsic aspects such as tested by the construct of over-commitment (Krause, Burgel and Rempel, 2010). This finding is strengthened by the longitudinal methodology of the study, as well as the use of a control group.

The Job Demand Control Model has been studied more extensively than the Effort-Reward Imbalance Model, especially in the context of MSD (Koch *et al.*, 2014). However, in a study with blue-collared workers, the Effort-Reward Imbalance model was found to be more finely-tuned to psychosocial risk factors for MSD than job strain as measured in the Demand Control Model (Yu *et al.*, 2013). This was supported by the findings of a large project researching nurses, where the Effort-Reward Imbalance Model was found to be better attuned to risk for MSD than the Job Demand Control Model (Lee *et al.*, 2014). The Job Demand Control Support Model, like the Effort-Reward Imbalance Model, also found that the combination of psychosocial and

physical factors and MSD increases work-related stress (Park and Jang, 2010). However, one must be cautious since a limitation of the study was the inability to measure other compounding factors. One could argue that this too could have a snow-ball effect on all of the factors.

In a first world population of neck and back pain patients, using the Demand Control Support Model to assess psychosocial factors, the authors found that the significantly high demands being made on employees could impact upon back and neck pain (Canjuga, Läubli and Bauer, 2010). This was also found in a study using the Copenhagen Psychosocial Questionnaire, where the only significant association with MSD was dissatisfaction in terms of the psychological demands made (Coelho *et al.*, 2015). The effects of a high demand level, in conjunction with a high level of control, caused individual growth through skill development, motivation and increased learning (Canjuga, Läubli and Bauer, 2010). The high levels of job control, described as decision latitude, also tend to have a positive effect in mitigating negative health outcomes. As neck and back pain are complex conditions, other factors cannot be completely ignored (Canjuga, Läubli and Bauer, 2010).

Although the Effort-Reward Imbalance Model has some drawbacks, its use in VDU has been assessed in only a few studies (Takaki *et al.,* 2006; Kraatz *et al.,* 2013; Koch *et al.,* 2014), and since it accounts for environmental, as well as intrinsic factors, it is a useful, validated model for assessing work-related psychosocial factors and stress.

In a study conducted in a First World population sample of healthcare workers by De Jonge *et al.*, (2008) the outcomes showed that Effort-Reward Imbalance and Over-commitment Questionnaires proved to be construct-valid measures of work stress, and determined that changes in the effort, reward and over-commitment constructs are not due to structural changes in the questionnaire over time.

Psychosocial factors also influence MSD through the biopsychosocial approach. The next section of the literature review covers MSD and the biopsychosocial approach to understanding pain, specifically in terms of pain beliefs. Further exploration of what pain beliefs are, how they affect pain, chronicity and disability are then discussed, as

well as interventions and confounding factors that add to the complexity of the pain experience.

2.2.4 Pain Beliefs

Pain is defined as 'an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage' (*International Association for the Study of Pain*, 2018). The biopsychosocial model is based on an integration of the biological, psychological and social areas in an attempt to explain disease/pain (*Merriam-Webster*, 2018). It is unlike the biomedical model that only addresses the biological construct. Pain beliefs constitute part of the psychosocial factors associated with pain. Pain beliefs, as defined by Williams and Thorn (p1, 1989), are 'patients' own conceptualisations of what pain is and what pain means for them'. Beliefs can change to conform to the individual's experience, and influence his/her behaviour (Williams, Robinson and Geisser, 1994) or help an individual understand the experience (Stroud *et al.*, 2000). Altered beliefs can become maladaptive, and magnify the intensity of the pain and distress (Stroud *et al.*, 2000), and thus have an effect on the perceptions of pain and functionality (Williams, Robinson and Geisser, 1994; Damsgård *et al.*, 2011), the response to treatment (Williams, Robinson and Geisser, 1994), the activity level, the frequency of reactions to the pain, and even depression (Baird and Sheffield, 2016).

Through an understanding of altered beliefs, interventions to address them can be implemented, and can thus improve function (Damsgård *et al.*, 2011; Baird and Sheffield, 2016). These findings are supported by Stroud *et al.,* (2000), who rationalised that intervention should address maladaptive cognitions and pain beliefs. Pain management methods, particularly in chronic pain, focus on beliefs, cognitions and associated behaviours (Baird and Haslam, 2013). Patients who regress into states of depression and disability after receiving a comprehensive rehabilitation plan, have developed beliefs that they are disabled and have perceptions that their ability to control their pain has been impaired. They tend to be increasingly guarded, are prone to catastrophising, and are convinced that they should be resting. These findings indicate that specific interventions are necessary to address pain-related beliefs and coping issues (Jensen, Turner and Romano, 2007).

Although Stroud's study was on a small scale, and dealt with a small population sample experiencing chronic pain, the need to establish individual beliefs or cognitions to understand an individual's pain responses became apparent. It was found that once the psychosocial factors associated with pain were established, this knowledge could then result in more effective interventions (Stroud *et al.,* 2000).

As pain beliefs are instrumental in experiencing pain, the influence that pain beliefs have, if any, on work-related MSD needs to be further investigated. Pain beliefs are discussed in the next section.

2.2.4.1 Pain Beliefs and Work-related MSD

Cultural and societal characteristics, health beliefs and expectations have been suggested as influences that give rise to the risk of MSD (Coggon *et al.*, 2012). This is suggested in a large-scale study, across continents, and although it used self-administered questionnaires across various occupations in blue and white collar workers, the findings indicate the need to investigate the circumstances within specific cultures. This is supported by a study of office workers where predictors for MSD for two respective cultures were found to be similar but were weighed differently between the sample groups (Maakip, Keegel and Oakman, 2017). For one culture the importance of some factors were less than the other. This means that interventions need to be tailor-made in accordance with the sample population in question (Maakip, Keegel and Oakman, 2017).

The belief that MSD are commonly caused by work, as well as somatising tendencies, was reported in a study of VDU as an independent risk factor for neck, shoulder and lower back pain (Oha *et al.*, 2014). Another ramification of pain beliefs can be seen in the self-reported assessment of work-station ergonomics, as individuals with pain evaluated the work station more negatively than those without pain. However, the researchers found no difference between the work stations of those experiencing pain as opposed to those without pain (Chiasson *et al.*, 2015). The belief that pain is permanent was found to be predictive of self-reported disability at three months following injury in a group of patients that had whiplash- associated disorders (Bostick *et al.*, 2015). This was predictive of this group's perceptions of the future outcome, as it was associated with disability (Bostick *et al.*, 2015). In this specific population sample,

belief in a medical cure, usually considered to be an altered belief, was unexpectedly associated with less pain and future disability (Bostick *et al.*, 2015).

The belief that pain is mysterious was found to be associated with disability at the six-month follow up (Bostick *et al.*, 2015). The sample group in this case was small and emotional factors such as distress were not considered. Hence, the findings should be extrapolated with caution. This does in fact indicate that research into various populations, cultures and areas of MSD are required.

One example of altered pain belief is when the pain is understood to be threatening. In some cases, this results in a fear of activity on account of the pain, and eventually the progression of a disability (Damsgård *et al.*, 2011). This is known as the Fear-avoidance Model since the fear of movement results in less movement, and then subsequently increased fear, diminished function, and finally disability (Waddell *et al.*, 1993). Fear-avoidance beliefs and the belief that the spine is vulnerable are strong predictors of increased absenteeism and time away from work, perpetuate pain and affect recovery (Marchand *et al.*, 2015).

Although other components also contribute to this cycle, a study of chronic pain sufferers found that by addressing fear-avoidance beliefs in the work context, the physical ability of the patient could be improved which could assist in the patient being able to return to work. This study involved only a small sample size, and were employed in various occupations (Vowles and Gross, 2003). In fact, the necessity for addressing the work-related fear-avoidance beliefs has proved to be more important than addressing the fear-avoidance beliefs and severity of pain associated with general physical activity. As pain severity has been found to have little or no effect the focus should be on other factors rather than on reducing the intensity of the pain (Vowles & Gross 2003). This would be feasible since pain-related fear results in a greater level of disability than the pain itself (Waddell *et al.*, 1993; Baird and Haslam, 2013; Myhre *et al.*, 2013; Baird and Sheffield, 2016). Furthermore, pain severity is associated with multiple factors, namely personal factors, work-related psychosocial factors and occupationally-specific factors (Govindu and Babski-Reeves, 2014). As such, pain intensity is not related to fear-avoidance beliefs (Myhre *et al.*, 2013). Although the statistical variance among categories proved to be sound, the above study by Myhre *et al.,* (2013), investigated only a heterogeneous sample of lower-back-pain sufferers,

who were remunerated to participate in the research. These factors could skew the results. A large-scale study, involving various factor analysis techniques, deduced that altered pain beliefs generally occur in a population experiencing chronic pain (Baird and Haslam, 2013) and that the development of pain beliefs is most likely in cases where the pain has had the greatest impact on function.

Other factors, besides psychosocial work factors that influence pain, include self-efficacy, loss of control, and depression, (Canjuga, Läubli and Bauer, 2010). In this large-scale study of a working population in a First World country, it is important to realise that no one factor works in isolation (Canjuga, Läubli and Bauer, 2010).

Pain-related psychosocial factors, fear-avoidance beliefs, and work-related psychosocial factors, effort and over-commitment, were found to be associated with one another in a study involving a group of patients suffering from neck and back pain who were booked off from work and listed as sick (Myhre *et al.*, 2013). Psychological distress was also at a higher level in the booked-off patients than in the reference group (Myhre *et al.,* 2013) and this could also contribute to the findings described above.

2.2.4.2 Pain Beliefs and Chronicity

In a recent review, the authors state that the mechanisms that allow for the progression from pain to disability are not entirely understood (Lee *et al.*, 2015). The concept that fear-avoidance beliefs cause changes in behaviour, and in turn affect activities of daily living and thus have the capacity to allow acute pain to progress to chronic pain was emphasised (Waddell *et al.*, 1993; Baird and Haslam, 2013). The fear-avoidance model suggests that chronic pain syndromes develop once the normal expected recovery is halted and when the individual is presented with pain as a threatening experience, presents with catastrophising tendencies, and a fear of pain, as well as anxiety (George and Stryker, 2011). The prevention of chronicity should include attempts to address the inappropriate fear-avoidance beliefs in the acute stage (Waddell *et al.*, 1993).

Chronic pain can be defined as pain that lasts three months or longer (*International Association for the Study of Pain*, 2018). Consensus in the literature suggests that chronic pain can lead to disability and loss of productivity, increased costs, and burden

of disease (Schim and Stang, 2004; Driessen *et al.*, 2011; Ye *et al.*, 2017). This can in turn influence income and quality of life (Schim and Stang, 2004; Wijma *et al.*, 2016).

Treatments that address beliefs increase the probability of improving function in the chronic pain patient (Vowles and Gross, 2003). This was evident in the study assessing function through return-to-work outcomes, where a reduction in fear-avoidance beliefs improved outcomes and was predictive of a return to work in the 12 months following intervention. The reduction in fear-avoidance beliefs presented with a substantial odds ratio of three to four for return to work over those patients with no change in their fear-avoidance beliefs (Marchand *et al.*, 2015). Fear-avoidance beliefs and catastrophising, which can later intensify the perceived severity of the pain, have been prioritised by Baird and Sheffield (2016) in managing chronic pain patients. Fear-avoidance beliefs also affect the perceived work-related physical demands more intensely than is the case in the healthy control groups (Waddell *et al.*, 1993). This is partly due to the relationship between fear and disability, and how fear of injury and re-injury can be hindrances to recovery (Baird and Sheffield, 2016). This could also be due to the nature of the self-sustaining feedback systems observed in chronic pain patients (Waddell *et al.,* 1993). As observed in the study by George and Stryker (2011), there seems to be a link between elevated fear-avoidance beliefs and high pain intensity, as well as with the associated self-reported functional levels. Fear-avoidance beliefs were found to be the strongest contributor to pain intensity. However, independently, fear-avoidance beliefs still tend to be the largest contributor to affect function. Pain beliefs and thoughts/cognitions have been positively linked to adjusting and adapting to chronic pain through positive adaptations and coping strategies, or can negatively impact upon adjustment through increased pain and distress. In a small sample of patients suffering from chronic pain, negative self-statements were related to poor adjustment, substandard adaptations to chronic pain, and unsatisfactory outcomes, more than pain beliefs. This was a cross-sectional study, and further study is required (Stroud *et al.*, 2000).

In order to better understand how pain leads to disability, a recent review, determined that self-efficacy, fear and psychological distress are mediators between pain and disability. Depression and anxiety, which have been found to overlap, also contribute to disability (Lee *et al.*, 2015). There is a lack of sound evidence that accurately defines

acute and chronic pain within the literature, making the review and conclusions in the literature between the two concepts difficult.

The belief that pain is related to injury, and that the intensity of pain is indicative of injury, is known as an organic pain belief (Baird and Sheffield, 2016). In terms of disability and pain, there is a strong correlation between these organic pain beliefs and self-efficacy (Baird and Sheffield, 2016). Mental health conditions such as depression and anxiety are also related to organic and psychological pain beliefs, self-efficacy and locus of control (Baird and Sheffield, 2016). In terms of mental health, depression and anxiety are strongly related to organic health beliefs (Baird and Sheffield, 2016). The intensity with which one believes the organic beliefs is a differentiating factor between a chronic pain population and the general population, in other words, chronic pain patients experience a more intense organic belief than the general population (Baird and Sheffield, 2016). Self-efficacy is an important predictor of depression, and depression is strongly related to organic health beliefs (Baird and Sheffield, 2016). At this point, one can see that the belief structures are intricately dependent. This study was conducted in a First World European country. As such, one does question its validity in South Africa. A developing country faces its unique challenges, and this is discussed later in the literature review.

Although it was a small study of only 669 office workers, chronicity developed in 17% of the participants who had initially reported neck pain and 27% who had initially reported lumbar pain (Sihawong *et al.*, 2016). Predictors for neck chronicity included a high body mass index, neck extension during the day, a high level of initial pain intensity and high job demands. Chronic back pain predictors included high levels of initial pain intensity and a previous history of low back pain (Sihawong *et al.*, 2016). The authors highlight the fact that high levels of disability in the office worker may not be as prominent on account of limited physical demands.

Established multi-site pain is likely to persist. A predictive factor in the perpetuation of multi-site pain is mental strain (Neupane and Nygård, 2017). It is important to note that physical strain is not associated with either the onset nor the persistence of multi-site pain. A five-year prospective study (Herin *et al.*, 2014) found that physical and psychological work-related factors seem to be predictive factors of multi-site MSD.

Psychological factors were predictive of the onset of MSD in women, and physical factors predictive of body site MSD in men. Age and sex affect the risk factors differently (Herin *et al.*, 2014). The study used data over the last two decades and might result in obsolete findings on account of the change in the nature of the work requirements and the pace and demands made upon a VDU user. More recent prospective studies may be needed. However, these findings do add value to the effects of psychosocial factors, sex and age on MSD.

The belief that pain is threatening and causes harm is much more prominent in an MSD chronic pain group than in a reference or non-chronic pain group. The presence of pain and the experience of it affect the individual's belief structure, as well as his/her perception of the weight that the belief carries. As such, interventions, that are aimed to change specific beliefs, have resulted in functional improvements (Baird and Haslam, 2013). In a heterogeneous population suffering from chronic pain, beliefs are uniquely and independently associated with disability and depression (Turner, Jensen and Romano, 2000).

Psychosocial factors of pain are specific to the individual in terms of the individual's beliefs, behaviours and thoughts (Baird and Sheffield, 2016). All three of the studies guide the process of intervention for the therapist to intercede in respect of the specific beliefs of the individual which, once established, must be directly addressed, and not through blanket interventions (Turner, Jensen and Romano, 2000; Baird and Haslam, 2013; Baird and Sheffield, 2016).

As the literature above indicates, interventions to address and manage pain need to be specific and individualised. However a randomised control trial found no difference in the return-to-work rate of participants with a specific intervention of work-focused rehabilitation over those subjected to the methods of a normal multidisciplinary team, therefore indicating that multidisciplinary treatments are as effective as specific work-related ones for return-to-work outcomes (Myhre *et al.*, 2014; Marchand *et al.*, 2015), as well as for changes in pain and disability (Marchand *et al.*, 2015). The assessment of pain and disability was conducted in the aforementioned study by Myhre *et al.,* (2014), and although the results are promising, the large drop-out figure, and the effects of the concurrent treatments of participants in the 12 months' follow-up period could influence the findings.

There has been a recent increase in pain neuroscience education (PNE) methods as an intervention to manage chronic pain. PNE is an educational process which focuses on explaining pain without using jargon, and removes it from the body context (Louw *et al.*, 2016). The systematic review by Louw *et al.*, (2016) highlights how more research is needed, however, to assess whether PNE actually addresses all psychosocial factors. The process of PNE seems to affect the chronic pain patient's perceptions of his/her disability, his/her catastrophising and changing organic beliefs - which in combination result in changes in his/her ability to physically move (Louw *et al.*, 2011).

Further studies are required, as this review pertains to only eight studies. The value of addressing psychosocial factors in combination with PNE and of further strategies focusing on active movement has apparently had the best pain intensity outcomes. Where PNE has been applied, follow-up assessments/visits on chronic pain patients have revealed a reduction in the use of health-care facilities and in sick leave applications (Louw *et al.*, 2016).

In order to assess pain beliefs, both the FABQ and the PBPI were used in this study. All of the tools and questionnaires used in this study are discussed below.

2.3 Assessment Questionnaire and Tools

The following section includes a review of the literature on the assessment tools used in this study. The individual factors were assessed via the amended Cultural and Psychosocial Influences on Disability (CUPID) Questionnaire. The Nordic Musculoskeletal Questionnaire was used to determine the prevalence and sites/location of MSD. The Rapid Office Strain Assessment (ROSA) was used to determine the ergonomic work-station set-up. The Effort-Reward Imbalance and Over-commitment Questionnaire was used to determine the psychosocial factors in the work place, while pain beliefs were assessed in the MSD group by the FABQ and PBPI.

2.3.1 Amended Cultural and Psychosocial Influence on Disability Questionnaire

An amended CUPID questionnaire, (Coggon *et al.*, 2012) was used as a framework for the demographics section of this study. The demographics used included age, gender, handedness, age, the cut-off point for the completion of full-time education, participation in physical exercise, length of physical exercise session, leave last taken,

the number of years spent working, the number of hours a week spent on this occupation, and the type of work-station set up for VDUs. The questionnaire was used in the CUPID study (Coggon *et al.*, 2012) across 18 countries. Like the Nordic Musculoskeletal questionnaire, this questionnaire included the site/location of the pain. It also covered functional changes, due to pain, general health, health beliefs, causes and prevention of pain, as well as psychosocial factors relating to self and work. The questionnaire was not used in other studies, except for the study by Coggon *et al.*, 2012.

2.3.2 Nordic Musculoskeletal Questionnaire

The Nordic Musculoskeletal Questionnaire is a standardised questionnaire developed in order to assist with occupational health services and screening for musculoskeletal disorders (Kuorinka *et al.*, 1987). The questionnaire shows an image of the body, with tick boxes of 'yes' and 'no' for the site/location of the 'trouble'. The questionnaire further expands on the definition of 'trouble' as ache, pain, discomfort or numbness (Kuorinka *et al*., 1987). The questionnaire relies on recall, as it asks for information relating to the previous 12 months, and again to the previous seven days. The original study suggests that the Nordic Musculoskeletal Questionnaire can be used in cross-sectional studies, as well as in measuring changes in interventions (Kuorinka *et al.*, 1987).

In a test-retest reliability testing, the non-identical answers varied from 0 to 23%, with no mention of a Kappa score (Kuorinka *et al.*, 1987). When the validity of the Nordic Musculoskeletal Questionnaire was tested by comparing the answers to details of the clinical history, the non-identical answers varied from 0 to 20%. As such, the reliability and validity of the Nordic Musculoskeletal Questionnaire was deemed acceptable (Kuorinka *et al*., 1987). It has a 0 to 20% discrepancy between non-identical answers for the validity of the clinical history (Kuorinka *et al*., 1987).

The Nordic Musculoskeletal Questionnaire asks for participants to recall MSD over the previous 12 months and the past seven days prior to its administration. On testing the questionnaire for its validity, reliability and appropriateness, the difference in the range of answers on follow up should vary from 7 to 26% (Crawford, 2007). The Nordic Musculoskeletal Questionnaire is also considered to be an adequate screening tool for comparing the sensitivity of the responses to the questionnaire to the results of the

clinical examinations. The questionnaire showed a sensitivity to MSD of between 66 and 92% (Crawford, 2007). This is slightly lower than the 82,3 to 100% found by (Descatha *et al.*, 2007). Their questionnaire specificity presented with ranges of 51.1 to 82.4% (Descatha *et al.*, 2007) and these results were supported by the review by Crawford (2007) putting the variation at a range between 71 and 88%. Although the reliability and specificity showed large variations, this questionnaire remains adequate for screening, but not for clinical diagnosis (Crawford, 2007).

The Nordic Musculoskeletal Questionnaire relies on accurate recall, and this could result in recall bias. The limitations of the questionnaire also include an unknown classification of MSD in that it could include any form of pain, discomfort or neurological symptom. However, as indicated in the discussion above, and since the study requirements included an MSD group and a reference group, its use proved to be sufficient for this study.

2.3.3 The Effort-Reward and Over-commitment Questionnaire

The concept studied by Siegrist (1996) in the Effort-Reward Imbalance Model argues that should one have failed to perceive reciprocity between effort expended and rewards received, one could experience repetitive negative emotions and a continual stress response. The three factors associated with reward are: esteem, promotion and security (Siegrist, Li and Montano, 2014).

The questionnaire consists of 16 questions for effort and reward, and six questions for over-commitment. Should the calculated Effort-Reward Ratio be higher than 1.0, this would imply significant efforts made, limited rewards received, and a high level of non-reciprocity and imbalance.

As described by Siegrist (2012), further calculations are needed for the sub-scores. By adding the answers pertaining to over-commitment, the participant can then be given a score. The higher the score, the higher the level of over-commitment. Both over-commitment and large Effort-Reward Ratio - non-reciprocity - are related to an increased risk of diminished health (Siegrist, 2014). Internal consistency in respect of an effort score of alpha 0.74, a reward score of alpha 0.82, and an over-commitment score of between 0.73 and 0.78 was considered to be satisfactory for this study (De

Jonge *et al.*, 2008). Test-retest stability was also considered to be satisfactory for effort (r=0.45-0.58) and over-commitment (r=0.45-0.53), but unsatisfactory for rewards (r=0.36-0.38) (De Jonge *et al.*, 2008).

2.3.4 Rapid Office Strain Assessment

A variety of risk assessment measures and methods to assess work stations, to implement change, and to manage MSD are featured in the literature. One such tool is the ROSA (Sonne, Villalta and Andrews, 2012). The tool takes approximately 25 to 35 minutes per assessment and completed in by a skilled individual. This includes a short introduction session with the participant about the ROSA, a 15-minute observational assessment to accurately fill in the ROSA, followed by an explanation of findings and if possible ergonomic correction. The higher the score on the ROSA, the higher the discomfort score. A score of five or higher therefore requires immediate adjustments. The relationship between discomfort and the ROSA final scores is expressed statistically in terms of a correlation value of r = 0.36, which in turn means that 13% of the discomfort experienced is accounted for by the rising ROSA scores. Considering its specificity to computer use in the work place, ROSA has been used with great efficiency and success in other studies, (Matos and Arezes, 2015; Poochada and Chaiklieng, 2015).

The ROSA was developed along the principles of neutral postures and the ergonomic guidelines of the Canadian Standards Association (Sonne *et al.,* 2012). The ROSA is meant to quickly quantify risks in a typical work station into low, medium and high. The risk assessment is aimed to assist the user to prioritise changes that are based on ergonomic standards, as well as discomfort scores (Sonne *et al.,* 2012). In the development of ROSA, the discomfort score was reported as a unit, regardless of the source of discomfort (Sonne et al., 2012). The authors used the Cornell University Discomfort Questionnaire to examine the frequency and intensity of discomfort experienced, as well as the worker's productivity (Sonne *et al.,* 2012).

In the aforementioned study, the participants included administrative staff using the computer for a period of at least 50% of the day. Confirmed by the findings from previous literature sources, this measure was then accepted as the norm for the

inclusion criteria (Mirzaei *et al.*, 2014; Oha *et al.*, 2014; Poochada and Chaiklieng, 2015).

The ROSA has three sub-scores that allow calculation of the final ROSA score. During the development of the ROSA, the intra and inter-observer reliability levels were assessed, with the intra-class coefficient (ICC) being 0.88 and the final ROSA score being 0.91 (Sonne *et al.,* 2012). Intra-observer reliability was assessed over four weeks, during which period a mock work station was evaluated (Sonne *et al.,* 2012). In its turn, the inter-observer reliability level was tested by assessing 14 work stations. The assessments were conducted by three trained observers, who worked together simultaneously to assess the respective work stations. Sonne *et al.,* (2012) felt that there might be a need to redesign the images in order to promote increased reliability. However, this should not be considered to be a great complication since this assessment method is similar to those of other assessment tools (Sonne *et al.,* 2012). The ROSA assesses the work station in terms of various areas, namely: the chair, monitor, telephone, keyboard and mouse. Sub-sections are grouped to allow for scoring, and then to determine the final ROSA score. Part of the scoring includes a time-related score in certain sub-sections (Sonne *et al.,* 2012). Long periods of time (of high duration) in front of a VDU result in additions to the score, while limited periods of time (of low duration) result, in reductions to the score. On the other hand, time periods of medium length (medium duration) make no difference to the score. The final score is derived from a chair score and a peripheral score (Sonne *et al.,* 2012). The scoring starts at 1 - with neutral posture - and scores increase as deviations from the neutral position increase (Sonne *et al.,* 2012).

The ROSA has been extensively used to quantify risk, as well as to analyse change in risk (Matos and Arezes, 2015; Poochada and Chaiklieng, 2015; Mani, Provident and Eckel, 2016). The risk level results varied in two separate studies. In the study by Poochada and Chaiklieng (2015), the call centre workers were found to be either at a high risk level (52.3%) or at a medium risk level (47.7%), whereas in a smaller-scale study by Matos and Arezes (2015) office workers were found to have ROSA mean scores of 3.61, indicating a medium risk. Poochada and Chaiklieng (2015) suggest that the reasons why workers were considered to be high risks for MSD were due to chair set-up, the tendency to lean forward over the desk, or to have no lumbar support, with

wrists being held in the non-neutral position and monitors being positioned too high. This was a study done in a developing country with a relatively young population group. The fact that only two risk levels were noted could indicate that the ROSA score is not all that sensitive, and results in the grouping of patients at only two levels.

Sonne *et al.,* (2012) state that the final ROSA score is only moderately correlated to discomfort, although the mean discomfort score is largest at final scores of four and five. The sensitivity of the ROSA at a score of five, as measured by Sonne *et al.,* (2012), is only 76%, and its specificity, 68%, but at the score increase, so does the sensitivity and specificity, as a score of six is 100% specific and 98% sensitive. A score of five was found to be significantly associated with discomfort and caused the developers of the ROSA to use five as an indication to initiate change. The likelihood ratio for a score of five was 2.4, which is higher than for both the scores of four and six. This does question the validity of this assessment for measuring risk. This 2.4 ratio was significantly associated with the probability of musculoskeletal discomfort, whereas scores of four and six have a ratio of less than two and are not significantly associated with the predictability of discomfort. These statistics do in fact question the use of the ROSA as a risk assessment tool.

On the other hand, in the study by both Sonne *et al.,* (2012), and Poochada and Chaiklieng, (2015), a positive association between the ROSA and MSD was established. Matos and Arezes (2015) also draw attention to the fact that although a final ROSA score may not be an indication of a high risk, it still warrants attention, as it is still a risk factor. This idea is supported by Widanarko *et al.*, (2015), which found supporting evidence to the effect that a combination of two known physical risk factors increases the risk for MSD, and therefore both should be addressed, even in the case of a low risk score in the ROSA. The study by Lapointe *et al.,* (2013) suggests that addressing even just one of the two factors could prevent the onset of MSD by 59%. This could have a considerable effect on public health.

The ROSA is one of only four assessment tools that were tested for validity, intra-observer reliability and inter-observer reliability (Rahman and Mohamad, 2017). Although, unlike other tools, the ROSA does not quantify posture in the same way, it does indirectly address it through assessments of its components. This includes

leaning forward on a chair, the position of the knees, shrugged shoulders, the height of the monitor which affects neck posture, reach, wrist extensions and the position of the neck with telephone use. Mirzaei *et al.,* (2014) collaborated on specific ergonomic recommendations in order to minimise ergonomic risk factors. The ROSA assessment follows a similar assessment method, including the recommendations, as described by Mirzaei *et al.,* (2014).

Self-evaluation of work stations has also proved to be inaccurate, as those who have MSD indicate less optimal work stations than those who do not have MSD (Chiasson *et al.*, 2015). This issue was not brought up by the VDU population sample but one could extrapolate these findings to any work station. Through an assessment of the ROSA in terms of the literature sources available to this researcher, an external assessor using ROSA would remain the best tool to assess ergonomic risk factors in this study since psychosocial factors and personal factors are concomitantly being addressed with other assessment techniques.

2.3.5 Fear-avoidance and Beliefs Questionnaire

The FABQ was developed to assess the fear-avoidance beliefs about physical activity and work (Waddell *et al.*, 1993). There are four questions for the physical activity section, and seven questions for the work-related section, which are labelled as the Fear Avoidance Beliefs Questionnaire - Physical Activity (FABQ-PA) and the Fear Avoidance Beliefs Questionnaire - Work (FABQ-W) respectively.

The questionnaire involves a scale of zero to six, where zero represents the option “completely disagree with the statement”, and six represents the option “completely agree with the statement”. The score for the FABQ-PA ranges between 0 to 24, and for the FABQ-W, 0 to 42.

There are gaps in the body of relevant information as to which population group this questionnaire could be directed at, as there is conflicting evidence for the use of FABQ in the acute population, as well as to its validity outside the lower back pain area of diagnosis (Waddell *et al.*, 1993; Williamson, 2006; Cleland, Fritz and Brennan, 2008). George and Stryker (2011) concludes that FABQ is appropriate for all MSD conditions and that the use of FABQ-W may be a more sensitive scale than others.

FABQ-W has also, proved to be a good screening tool for the prediction of poor outcomes in work-related lower back pain, (Cleland, Fritz and Brennan, 2008). Among patients receiving Workman's Compensation benefits, the FABQ-W cut-off (29 points) was found to be predictive of a poor outcome (Cleland, Fritz and Brennan, 2008). FABQ has not, however, proved to be predictive in the private insurance category of patients (Cleland, Fritz and Brennan, 2008). In the patients receiving Workman's Compensation benefits, FABQ-PA and FABQ-W contributed to the mediation of pain and the return to work; but only FABQ-PA, and not FABQ-W, influenced disability in a population group suffering from acute and sub-acute pain.

Contradictory to the findings of Cleland, Fritz and Brennan, (2008), the study by Marchand *et al.,* (2015) found that FABQ-W or FABQ-PA had no influence on disability in the chronic pain population group. Rather, the FABQ-W is related to the length of time off work (Williamson, 2006), while the effects of pain and the return to work are mediated by both sub-scales of the FABQ (Marchand *et al.*, 2015).

In patients with neck and back pain, positive associations have been found between a lower FABQ-W score and increased age, as well as between a lower FABQ-W and highly skilled white-collar occupations (Myhre *et al.,* 2013). The finding that the white-collar workers would have lower FABQ-W scores could be due to the lower physical demands being made upon them. Considering the factors mentioned above, the validity of assessing FABQ in this population needs to be assessed.

An elevated score is considered to imply inappropriate fear-avoidance beliefs. However, there are no clear-cut values (Williamson, 2006). The conclusion that was drawn in just two studies was that an FABQ-PA score above 15 should be considered to be elevated, whereas an FABQ-W score above 34 was seen to be linked to poor return to work outcomes. There is a need to further research to establish clinically relevant changes in scores (Williamson, 2006).

An FABQ-W score of a more recently conducted randomised control trial found that a change in FABQ-W of 12 or more resulted in three to four times increased likelihood for a chronic pain patient to return to work (Marchand *et al.*, 2015). The suggestion in this case was that the minimal detectable and clinical change in the FABQ-PA score would be 4/24 and 9/24 respectively. On the other hand, the FABQ-W score suggested only a minimal detectable change of 12/42 (Inrig *et al.*, 2012). The validity of a cut-off

score of 29/42 for the FABQ-W score proved to be accurate in detecting poor outcomes in a Workman's Compensation group, but was not useful in private patients. Furthermore, the FABQ-PA cut-off score of 13/24 was not found to be valid for the prediction of outcomes (Cleland, Fritz and Brennan, 2008). This could be due to the questioned validity of the FABQ-PA on account of its narrow scope. On the other hand, the FABQ-W may be more sensitive in ascertaining beliefs around work, as work has a strong influence on social role factors, which could impact upon disability (George and Stryker 2011).

In an appraisal of the literature regarding the FABQ, the test-retest reliability of the FABQ as a whole proved to be excellent at 0.97 and, independently, that of the FABQ-PA acceptable at 0.72 to 0.90, while that of the FABQ-W was high at 0.8 to 0.9 (Williamson, 2006). The FABQ-PA was found to be significantly correlated with the change in disability ($r = –0.32$) and change in pain ($r = –0.26$). Furthermore, the FABQ-W was found to be significantly correlated to both the change in pain ($r = –0.39$) and disability (Cleland, Fritz and Brennan, 2008). The total FABQ proved to have excellent test-retest reliability (ICC = 0.97) over a 30-minute period (Williamson, 2006) and the Cronbach alpha scores for FABQ-W and FABQ-PA were 0.88 and 0.77 respectively (Coutu *et al.*, 2008).

With all the uncertainty as to what the FABQ really measures, the recent comprehensive review does question whether the fear-avoidance beliefs model does in fact follow the suggested chronic pathway (Lee *et al.*, 2015). This does make one wonder whether the model is accurate and whether the FABQ is valid. However, as this study aims to establish whether such beliefs do in fact exist in the VDU user, the FABQ is sufficient for this objective.

2.3.6 Pain Beliefs Perception Inventory

The PBPI (Williams and Thorn, 1989) was designed to assess beliefs, and the four factors were further defined to include, Pain as a Mystery, Self-blame for Pain, Pain Permanence and Pain Constancy (Williams, Robinson and Geisser, 1994). The PBPI was derived through an assessment of patients in terms of their pain beliefs. The seven areas that conceptualise pain include the belief that pain will stop, the cause of the pain, the mysterious nature of pain, how pain affects life style, the control of pain,

beliefs as to who or what to blame for the pain, and the question as to whether pain is experienced intermittently or constantly (Williams and Thorn, 1989).

Further analysis discovered that three of the seven factors are the most appropriate; namely, the question concerning the intermittent versus the continuous nature of pain, known as the Time Factor; beliefs regarding the future duration of pain, labelled as Pain as a Mystery, and the Self-blame scale. These factors are suggested to be fundamental for the development of pain beliefs. In terms of the time factor, it relates to the belief that pain is and will be an enduring part of life. Positive time beliefs differ from the cultural norm that pain has a time limit and can be healed (is fixable). A belief in the mystery of pain is indicative of a perception of pain as a mysterious aversive episode that is not well understood. A positive “mystery” belief differs from the cultural norms that state that pain can be considered to be a useful warning system. Self-blame is the belief that the individual is to blame for his/her own pain experience (Williams and Thorn, 1989). By definition of the tool, pain as a mystery is an indication of cognitive destabilisation and can perpetuate such a state. The time factor predicts somatisation and tends to be associated with the behavioural aspects of the pain experience. A loss of self-efficacy, and a negative self-perception are associated with the time and mystery factors (Williams and Thorn, 1989).

Pain intensity is related to the belief that pain will be enduring, or the time factor - more than the actual duration of the pain. Mystery and self-blame are not related to pain intensity. Poor compliance with therapy has been correlated with the mystery factor. However, this has been seen retrospectively in the data analysis, and should, therefore, be integrated into practice with caution (Williams and Thorn, 1989).

The self-blame factor seems to be correlated with frequent episodes of pain (Herda, Siegeris and Basler, 1994), and in their formulation of the hypothesis, the authors suggested that self-blame be negatively associated with the severity of the symptoms. The findings for the associations between PBPI and the respective psychological tools are inconsistent. As such, further studies are necessary to heighten the understanding of the association between these variables, and later assess the actual situation through longitudinal studies (Mikail, D’Eon and De Gagné, 1996).

The development of the PBPI brought to light three separate, unique factors, which are said to independently assess different facets of pain beliefs. Williams and thorn (1989) felt that on account of the low correlation score between these factors, this could be indicative of the three factors assessing completely different constructs

Although the concept of the PBPI is well written, the PBPI was based on a small sample of blue-collared patients suffering from chronic pain who were all receiving Workman's Compensation benefits (Williams and Thorn, 1989). In a later study, the PBPI was further evaluated on the basis of four sample groups (Williams, Robinson and Geisser, 1994). The PBPI constructs as well as their correlations with behavioural, psychological variables and coping strategies were investigated (Williams, Robinson and Geisser, 1994), and supported the mystery and self-blame factors. However, with further analysis, it was decided that the time factor should be differentiated into two. Time was now labelled as acceptance and constancy. Acceptance beliefs imply that pain is an enduring part of life. Constancy beliefs include the recognition of the temporal aspects of pain, where the belief is that pain is either intermittent or constant. Further discussion changed the acceptance label to permanence so as not to negatively or positively confuse concepts with the term Acceptance, and correctly label the construct (Williams, Robinson and Geisser, 1994). With access to the added benefit of factor analysis, an improved scoring system was devised, and accepted (Williams, Robinson and Geisser, 1994). A positive score in each factor is indicative of an endorsement of the belief in question (Williams, Robinson and Geisser, 1994).

Further investigation into the PBPI by Strong, Ashton and Chant (1992), using four small sample groups added to the body of knowledge of the constructs. All the samples presented with 24% to 76% of the individuals receiving Workman's Compensation benefits. All of the individuals had various sites of chronic pain, and no information was given about the work status of those not receiving workman's compensation benefits. In terms of age and sex and the PBPI, no age differences were noted. However, the men in the sample groups reported that they were more inclined to agree with the mystery belief than women. Unlike other studies, the p-value in this study was set at 0.006 (Strong, Ashton and Chant, 1992).

When the PBPI was studied in the group of patients suffering from chronic lower back pain, not one of whom was receiving Workman's Compensation benefits, the four-

factor solution and not the initial three-factor solution, was supported (Strong, Ashton and Chant, 1992). A later study, supported the four-factor analysis, but did not find sufficient evidence for the relationship between PBPI and the coping strategies. As such, further research and evidence are needed (Morley and Wilkinson, 1995).

The PBPI is able only to assess beliefs, but not to predict behaviour. However, beliefs have been said to be precursors to behaviour and do in fact influence future actions (Williams, Robinson and Geisser, 1994). Further studies investigating the accessibility of various tools to assess psychological domains found that none of the tools could come up with sufficient evidence to consider them to be suitable to determine work disability (Coutu *et al.*, 2008).

The internal consistency values for the time and mystery factors were found to be 0.80 respectively, and for self-blame, 0.65 (Williams and Thorn, 1989). Internal consistency scores in a population group where only eight percent (8%) were receiving Workman's Compensation benefits or were involved in legal proceedings were as follows: self-blame: 0.80, mystery: 0.68, and the time factor assessed as permanence: 0.74, and constancy: 0.72 (Stroud *et al.*, 2000). The internal consistency scores for patients with chronic lower back pain who were not receiving Workman's Compensation benefits were 0.78 for time, 0.74 for mystery, and 0.67 for self-blame (Strong, Ashton and Chant, 1992). The internal consistency of each score classified as mystery, self-blame, constancy, and permanence was 0.83, 0.89, 0.80 and 0.81 respectively (Morley and Wilkinson, 1995). In a chronic heterogeneous population, self-blame, constancy, permanence and mystery were listed as 0.7, 0.75, 0.76 and 0.63 respectively (Mikail, D'Eon and De Gagné, 1996).

The only study that assessed test-retest reliability was done over a six-month time frame, and at two-week intervals. The results showed values of between 0.49 and 0.67 for the two-week follow up for the various factors. The values at six months were 0.43 to 0.59 and are largely due to the large drop-out in the returns of the PBPI (Mikail, D'Eon and De Gagné, 1996). These values indicate that the PBPI was stable over time.

The PBPI establishes beliefs of pain in terms of mystery, self-blame, constancy and permanence, and the aim to establish whether VDU users have altered pain beliefs makes this questionnaire appropriate for this study.

2.4 Research and MSD in a Developing Country

The above-mentioned studies were primarily undertaken in First World countries. Only one recent study included South Africa as one of the 18 countries in which culture, beliefs and psychosocial aspects of MSDs were investigated and assessed.

By means of a questionnaire directed at South African office workers, Coggen *et al.,* (2012) established a baseline percentage of work-related psychosocial factors. The participants felt that in the work context they were experiencing financial incentives for their performance (52%); were experiencing time pressures (95.2%); were lacking in choices/options (37.6%); were lacking in support (21.8%); were experiencing job dissatisfaction (43.7%); and were experiencing uncertainty in job security (66.4%).

Zakerian and Subramanian, (2011) investigated a sample population of VDU users, in a developing country. Although the study did not specify the sites of MSD, and proved only slightly statistically significant ~~statistically~~, job control, social interactions and a new factor of computer-related problems were found to be positively associated with MSD (Zakerian and Subramanian, 2011). In VDU users in a developing country, the most significant factor is related to physical demands and musculoskeletal discomfort (Maakip, Keegel and Oakman, 2017). This was supported in a study in Kenya where job support, control, satisfaction and security were not found to be associated with MSD (Abaraogu *et al.*, 2018). This might be due to the young sample population, with inclusion criteria of only one month in the occupation in question. This finding is contradictory to the above-mentioned study, where support, psychological demands (Wahlstedt *et al.*, 2010) and job satisfaction (Maakip, Keegel and Oakman, 2017) were in fact found to be associated with MSD. This could also be due to the fact that employers in developing countries have been reported to lack awareness in psychosocial factors and stress at work (Kortum, Leka and Cox, 2011; Widanarko *et al.*, 2015).

With very little data in respect of the South African population, data from developing countries such as India might be a good starting point. As the study on Information Technology professionals was conducted in India, showing that psychosocial factors influence biomechanical demands and result in physical changes through muscular and cardiovascular load, could be considered to be relevant to the South African situation as it too is a developing nation (Mehta and Parijat, 2012). In Malaysia,

a developing nation, an unsatisfactory work-life balance is associated with an increase in musculoskeletal discomfort (Maakip, Keegel and Oakman, 2017). This was not found to be the case in First World countries, and could indicate that work/life commitments in a developing country may cause greater imbalances, and subsequent musculoskeletal discomfort (Maakip, Keegel and Oakman, 2017). There is a need for studies to be conducted in developing countries, as well as specifically in South Africa.

2.5 Intervention Strategies for mitigating MSD in VDU users

Suggestions for primary prevention include increasing activity levels and optimising ergonomic and organisational change (Green, 2008). Interventions in the work place to curb and prevent MSD and discomfort have been well studied and reviewed (Van Eerd *et al.*, 2016). The review by Van Eerd *et al.,* (2016) found positive evidence of moderate methods for stretching exercise programmes alone. Another study investigated a combination intervention of stretching and ergonomic modifications which showed no difference between the groups in the short term (Shariat *et al.*, 2017). The follow up at six months showed the most sustainable outcomes in the exercise group (Shariat *et al.*, 2017). The study consisted of a small sample group, with a relatively high drop-out rate, and unblinded researchers, but even with all the limitations, it is promising to note that multi-factorial approaches and movement interventions seem to be effective in bringing about change (Shariat *et al.*, 2017).

Prevention strategies for MSD should include ergonomic training for workers, as well as factors based on ergonomic principles to address in the workplace (Poochada and Chaiklieng, 2015). Evidence suggests that addressing social support in intervention programmes to manage MSD may be a positive influence for working against the trend of absenteeism at work (Woods 2005). Although promising outcomes were seen in addressing work style in a 12-month follow-up period, more research is needed in this field to refine interventions (Meijer, Sluiter and Frings-Dresen, 2008). Oha *et al*., (2014) warns of presenting computer work as hazardous to one's health and that these views may modify beliefs that are not conducive to good health. The suggestion by Oha *et al.,* (2014) was to instead create a supportive and valued environment in the work place.

The significant association between limited rest breaks and neck complaints in VDU users has been well studied (Kaliniene *et al.*, 2013; Celik *et al.*, 2018). A correlation

between the practice of taking rest breaks and a reduction in the intensity and frequency of neck pain has also been shown (Wu *et al.*, 2012; Sun, Nimbarte and Motabar, 2017). Interventions based on these findings were undertaken, as in Osama, Jan and Darain, (2015). It showed exercising groups to be more effective than rest breaks alone in preventing discomfort arising from MSD. This was the case in a small study population.

The systematic review on the effects of breaks found that active breaks are better than passive ones (Waongenngarm, Areerak and Janwantanakul, 2018). Active breaks are effective in mitigating and preventing lower back pain (Waongenngarm, Areerak and Janwantanakul, 2018). The drawbacks found in the review included short follow-up visits, mixed sample groups, and various methodologies. Another review found only moderate evidence in favour of rest breaks (Leyshon *et al.*, 2010).

Although various standards and recommendations regarding work-station set-ups have been reviewed, the comfort and ease of the end user are also essential factors to consider (Woo, White and Lai, 2016). As in the study by Asundi, Odell, Luce and Dennerlein (2012), the biomechanical effect of an altered incline on notebook computers and the participants' comfort were assessed. Their study illustrated how even though an incline to raise the notebook computer was able to improve the head and neck posture, which is advantageous biomechanically, and was accompanied by a less perceived and reported physical discomfort score, the less ergonomically-sound set up had higher ratings concerning the perceived ease and comfort of the work-station configuration (Asundi *et al.*, 2012). The recommendation to users was to forfeit neutral wrist positions by using an incline and to rather improve the neck posture (Asundi *et al.*, 2012). The study had its limitations, including a small group of participants who were assessed for a short period of time in various ergonomic set ups.

There is moderate evidence to the effect that forearm support improves upper quadrant comfort and reduces pain in the neck, shoulder and upper quadrant (Leyshon *et al.*, 2010; Wærsted, Hanvold and Veiersted, 2010). Even though the quality of the studies reviewed by Leyshon *et al.,* (2010) varied, this aspect was again supported by Van Eerd *et al.,* (2016) in a later review.

Although the review by Leyshon *et al.,* (2010) found moderate evidence to support the use of ergonomic counselling and group training as an intervention method to improve comfort, it was unclear as to what the specifics of the intervention included. In a small-scale study, and through training and education, participants were able to improve their knowledge of risk factors associated with MSD (Mani, Provident and Eckel, 2016). Re-assessment of their work postures and behaviours indicated less risk following the intervention. However, as there was no follow up, long-term effects cannot be concluded (Mani, Provident and Eckel, 2016).

A similar study, used training and education sessions on the ergonomic work station to assess change in MSD, and found that, as opposed to the control group, the intervention group effectively minimised MSD (Choobineh *et al.*, 2011). This study found that not one psychosocial factor was significantly associated with MSD; nor did the factors change after intervention (Choobineh *et al.*, 2011). This is not surprising as they were not pertinently addressed (Choobineh *et al.*, 2011). The lack of associated psychosocial factors is interesting but this could be due to the small sample size. Ergonomic training, including access to technical knowledge as to the correct work-station set up, risk factors, correct posture and adjustments in the VDU work station, were found to reduce ergonomic risk in the VDU work station (Mirmohammadi *et al.*, 2012). This was a small-scale study, and conclusions were drawn based on a short follow-up risk assessment.

There are also alternative methods to implement an optimal ergonomic work station. Robertson, Huang and Lee (2017) addressed this multi-factorial problem with a multi-factorial approach. The intervention included addressing all of the organisational aspects (e.g. work-place change, individual aspects and ergonomic training) through what is defined as a macro-ergonomics approach (Robertson, Huang and Lee, 2017). By addressing individual aspects, including training in respect of office ergonomics, it was evidently possible to improve on the work-station set up, which might have an effect on mitigating the magnitude of the risk for contracting MSD. Interestingly, training also proved to be effectual in influencing psychosocial factors (Robertson, Huang and Lee, 2017). The use of such an intervention is two-fold, with individual changes and the alignment of corporate goals through increased productivity (Robertson, Huang and Lee, 2017).

An earlier study, based on the same principles, had the same effects as those described above, with not only a reduction in the risk factors, but also a reduction in the intensity, duration and frequency of MSD in the upper quadrant (Esmaeilzadeh, Ozcan and Capan, 2014). Both studies, however, had a short follow up of only six months.

Using technology for self-classification is a novel approach for dividing individuals into exercise-intervention groups that are based on an algorithm (Lee *et al.*, 2017). The self-formulated algorithm to allow participants to receive a more tailored programme seems to have had an effect on pain intensity and physical health (Lee *et al.*, 2017). There was no significant change in FABQ. Although this was a small study group that used a self-formulated algorithm that could be biased (Lee *et al.*, 2017), it does show promise in the use of technology to drive change.

Hands-on methods may also be effective. In sample populations with neck pain, the activation of the postural muscles are impaired (Falla *et al.*, 2007; Wegner *et al.*, 2010). However, specific postural correction cues result in the improved activation of the crucial postural muscles - and this is more so the case than with general advice (Falla *et al.*, 2007; Wegner *et al.*, 2010). The use of facilitated postural correction through ergonomic training might be a useful tool to use in intervention strategies, and warrants further longitudinal studies.

Another method to correct posture includes EMG-based feedback (Park and Jang, 2010). The use of EMG feedback is effective in changing and improving posture (Park and Jang, 2010). Studies to assess its practical implications in the work place and in larger samples are needed. The strongest evidence for the effective treatment of upper extremity MSD was found to lie in the use of resistance training programmes at the work place. These were aimed at the prevention and management of MSD (Van Eerd *et al.*, 2016). The participants were employed in various professions, but the sample did include VDU users.

Collaborative planning with VDU users to reduce neck and back pain through the process of Participatory Ergonomics has been found to assist with recovery rather than to affect prevalence (Driessen *et al.*, 2011). As chronicity is linked to psychosocial factors, the intervention could have addressed these, thus resulting in recovery rather than prevention (Driessen *et al.*, 2011).

No change in outcomes could be found in a large-scale study assessing the difference between a treatment plan devised by a multidisciplinary team, as opposed to specific return-to-work treatment principles on sick-listed patients, (Marchand *et al.*, 2015). This was supported by Myhre *et al.,* (2014) and is suggestive of using a multidisciplinary team approach to address disability.

3. Conclusion of the Literature Review

The literature indicates the significantly daunting burden of work-related MSD, as well as the complexity of the multiple factors surrounding MSD. On account of the large majority of correlation studies and the multiple outcome measures, conclusions about causation and a comparison of outcomes are difficult to make. On the one hand, there is a body of literature regarding the biopsychosocial aspects of pain as a construct, while on the other, occupational health interventions seem to be focused on a biomedical or psychological construct only. The collaboration of psychosocial and biopsychosocial approaches to pain in the study objectives in the reviewed literature is minimal. These interventions are usually imposed upon individuals who have already left the work force. In order to better implement interventions and prevention strategies, an accurate understanding of and clarity on all of the associated factors that best explain the MSD burden are required. Further exploration into the appropriate multidisciplinary fields is warranted.

4. Rationale for the Study

As seen in the literature above, in order to explore the various factors that could influence work-related MSD, this study aimed to investigate the ergonomics of the work station, the associated individual factors, and work-related psychosocial factors that could contribute to MSD, by comparing these to those same factors in a reference group. Further explorations of the potential psychosocial factors relating to pain in a working population were also undertaken.

CHAPTER 3: METHODOLOGY

3.1 Study Design and Setting

This was a cross-sectional, observational study, and followed the STROBE methodology (von Elm *et al.*, 2014). The study was conducted at the work stations of various companies in Gauteng, South Africa. The selection of the companies was based on the consent received by their human resource departments for this researcher to gain access to their employees as potential participants in this study. The invitation was extended to companies that the researcher was able to get human resource department contact details. Of all the invites sent out, only three replied. Consent from the respective human resources departments was received in 2017 for data collection to commence in early 2018. The data collection process, barring the pilot study, was all conducted in March 2018. The month of March was also indicated as a time that was convenient to the companies. The decision to complete the data collection process in a condensed time period of the year, was an attempt at minimising the effect of external influences. The majority of companies encourage employees to take their annual leave over December, and owing to the seasonal changes in work load, employees tend to experience less pressure from their employers during this quieter time of the year. The effect of the end of the financial year being at the end of February, the pressure of work, and the elapsed time since leave had been taken, to name but a few contributing risk factors, would presumably result in more accurate risk exposure for the sample group in the month of March. Owing to the cross-sectional nature of the study, there was no follow-up and only a once-off data collection period.

3.2 Participants

3.2.1 Source of Participants

A sample of convenience consisting of VDU users in various corporate companies in Gauteng, South Africa, was invited to participate in this study. Participants were in the fields of administration, information technology and research. For confidentiality reasons, the identities of the companies are not named.

3.2.2 Sample Selection

Inclusion Criteria

Participants 18 years old and above, using a VDU at work for more than four hours a day, working more than 12 months in the current job or a similar occupation were

considered for inclusion in this study (Lapointe *et al.*, 2013; Mirzaei *et al.*, 2014; Oha *et al.*, 2014; Poochada and Chaiklieng, 2015). This was to allow for sufficient exposure over time.

Exclusion Criteria

Employees who had undergone surgery for MSD in the last two years were excluded, as well as participants undergoing mental health treatment, including but not limited to depression and anxiety. Both surgery and a mental health issue could influence the participants' beliefs and the outcome measures used and might have distorted potential interventions should outcomes have shown promise (Wu *et al.*, 2012; Kaliniene *et al.*, 2013). (Refer to Appendix A for the information sheet and consent form).

Sample size calculation

In order to determine the minimum sample size for correlational analysis, G*Power (version 3.1.9.2) was used to calculate the *a priori* sample size required to achieve a power probability of 0.95 at the 0.05 alpha level (two-tailed design), using a moderate effect size (r=0.3). A total of sample size of 42 was necessary for this section of the analysis.

The sample size required to analyse the difference between the MSD and reference group was 128, with 64 participants in each group. This was calculated by G*Power (version 3.1.9.2) with a power probability of 0.8 at the 0.05 alpha level (two-tailed design), using a moderate effect size (Cohen's d = 0.5) and an equal allocation of participants in each group.

3.3 Questionnaires and Assessment Tools

The study used validated questionnaires and assessment tools. The use of standardised self-reported outcome measures allowed findings to be comparative with other studies. A summary of the instrumentations is seen in Table 3.1. Detailed discussion of the Effort-Reward Imbalance and Over-commitment Questionnaire was discussed in the literature review as was the Nordic Musculoskeletal Questionnaire, ROSA, FABQ and PBPI.

The CUPID was amended, retraining portions of the individual demographics, while removing any work-related psychosocial factors and MSD questions. Instead, the Effort-Reward Imbalance and Over-commitment Questionnaire and the Nordic Musculoskeletal Questionnaire catered for the assessment of work-related psychosocial and MSD factors respectively. Furthermore, to minimise the length of the questionnaire, questions relating to functional work tasks that were not relevant to VDU users (e.g. kneeling or lifting 25kg weights or more) were excluded. (See Appendix B for the Amended CUPID Questionnaire.)

The questionnaires used in this research study are presented in the Appendices Section of this dissertation. The references are as follows:

- The Effort-Reward Imbalance and Over-commitment Questionnaire (Siegrist, 1996): Appendix C
- The Nordic Musculoskeletal Questionnaire, (Kuorinka *et al.*, 1987): Appendix D
- The Rapid Office Strain Assessment (ROSA forms) (Sonne *et al.,* 2012): Appendix E
- The Fear Avoidance Beliefs Questionnaire (Waddell *et al.,* 1993): Appendix F
- The Pain Beliefs and Perceptions Inventory in Appendix G (Williams and Thorn, 1989): Appendix G

Figure 3.1 explains the scoring system in order to reach a final ROSA score. Six facets of the work station contribute to the final score.

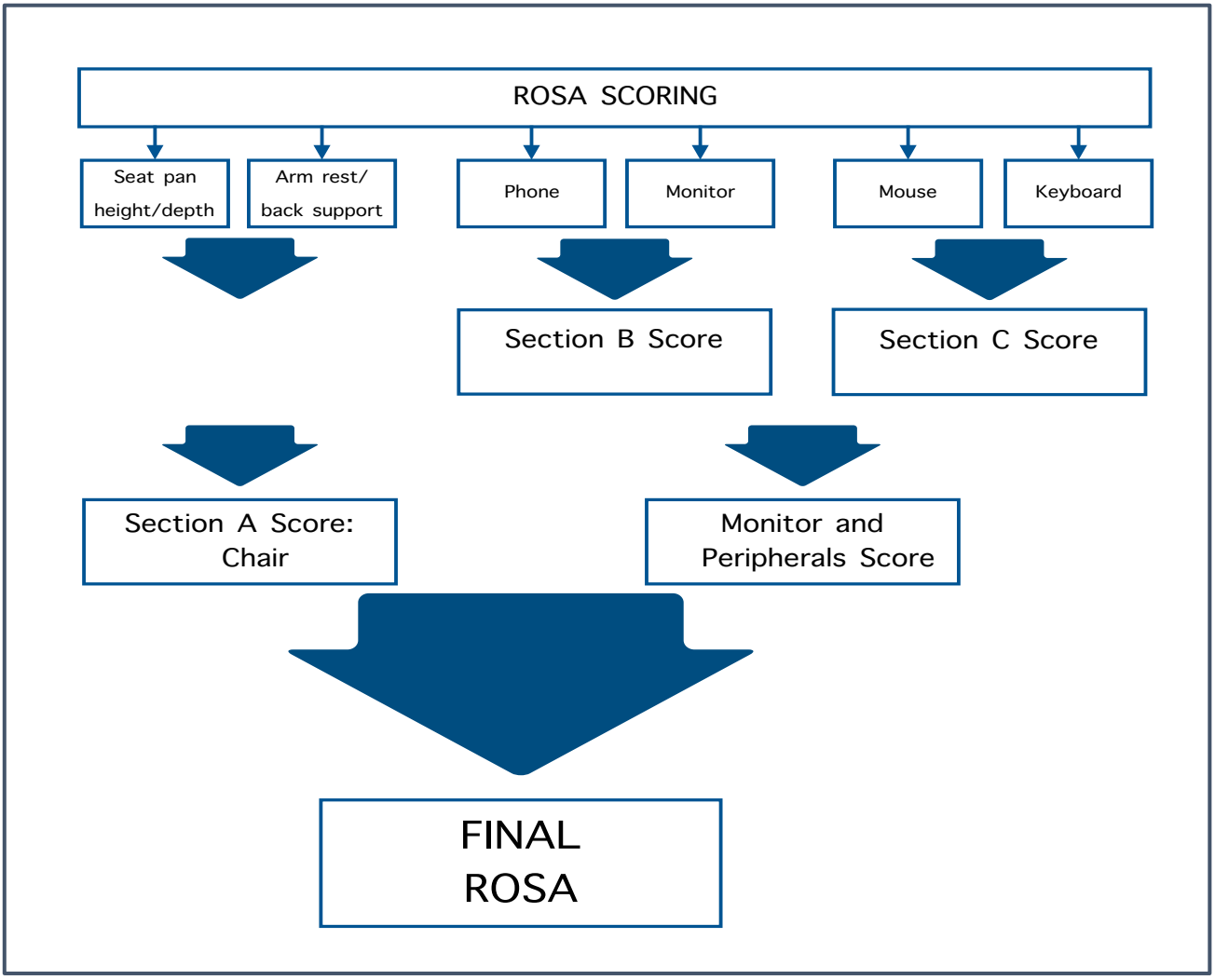


Figure 3. 1 Diagrammatic representation of ROSA scoring system

Details of the respective research tools (questionnaires and assessments) used in this research are presented in Table 3.1 below.

Table 3. 1 Outcome Measures

Outcome measure	Type of Data/ Use of tool	Method of data collection
The Amended CUPID Questionnaire (Coggon *et al.*, 2012; Wu *et al.*, 2012)	• Gender, Age • Work factors, number of hours worked • Physical activity • Highest level of education • Leave taken	• Completed by all participants online via Research Electronic Data Capture (REDCap) (Harris *et al.*, 2009)
The Nordic Musculoskeletal Questionnaire (Kuorinka *et al.*, 1987)	• Addresses the area of pain in: • The previous 12 months • The previous seven days • The effect of pain on activities • Whether MSD resulted in a physician consultation • Yes/no answers by body area	• Completed by all participants online via REDCap
ERI and Over-commitment Questionnaire (Siegrist, 1996)	• An assessment for testing health • Assesses effort, reward, the Effort-Reward Ratio and over-commitment • 16 Questions for ERI, six for over-commitment on a Likert scale: strongly disagree, disagree, agree, strongly agree	• Completed by all participants online via REDCap
ROSA (Sonne, Villalta and Andrews, 2012)	• Assesses the ergonomic risks in the work station, including time spent in front of a VDU, based on discomfort scores • 1-10 scale, with 10 being the highest • 5 or more: warrants immediate action.	• All participants were assessed by the researcher at the work station
FABQ (Waddell *et al.*, 1993)	• A measure of patients' beliefs that physical activity would lead to increased harm • Two Scores: FABQ-PA, Questions 1-5 and FABQ-W Questions 6-16	• Completed by participants who answered 'Yes' to the Nordic Musculoskeletal Questionnaire • Only the MSD group's answers were analysed
PBPI (Williams and Thorn, 1989)	• A measure of patients' beliefs regarding pain in the following categories: mystery, permanence, constancy and self-blame	• Completed by participants who answered 'Yes' to the Nordic Musculoskeletal Questionnaire • Only the MSD group's answers were analysed

3.4 Procedure

3.4.1 Pilot Study

As described in the main study, a pilot study was conducted. Its main aim was to discern any areas of bias and to streamline the data collection process. The pilot study involved 10 participants, 10% of the minimum required sample population. No changes were made to the procedures after the pilot study. As such, these data were analysed together with the data collected in the main study.

3.4.2 Main Study

Prior to the data collection stage, permission to access employees was obtained from the human resources departments of the companies in question, (Appendix H). Each participant was subjected to an onsite informed-consent information session, and after the participant had signed consent to participate, the link to the online questionnaire was emailed to him/her. REDCap, hosted at the University of the Witwatersrand (Harris *et al.*, 2009), was used for online data collection.

The participant filled in the online self-reported questionnaire at his/her work station. All participants filled in the questions relating to individual and work demographics, as well as the Effort-Reward Imbalance and Over-commitment Questionnaire and the Nordic Musculoskeletal Questionnaire. In cases where the participant had any MSD site, the FABQ and PBPI questionnaires were filled in. The participant was asked whether, to his/her knowledge, the MSD was related to factors other than work in order to allow for the correct allocation of participants to either the MSD group or the reference group.

While the participants were completing the questionnaire, the researcher observed the respective work stations and in each case completed the ROSA. The ROSA was presented to all participants, regardless of any MSD complaints. At that point, the researcher was unable to be biased toward a specific group as the results were unknown to her. Once the participant had completed all questionnaires on REDCap in full, at the end of the session, feedback about ergonomic work-station risk factors and adjustments was given to all willing participants. On account of the time needed for each participant, as well as the need to collect all data in such a large group in such a short time frame, the services of a research assistant were used to allow for efficient

time management. The research assistant helped in the process of obtaining informed consent and emailing the questionnaire link to participants. The data were collected in a time frame of one month in order to minimise external influences across the sample. The main researcher began filling in the ROSA once the participant had signed the consent form and started responding to the questionnaire. Only the main researcher dealt with the ROSA and training. This allowed for consistency in the application of the assessment tool.

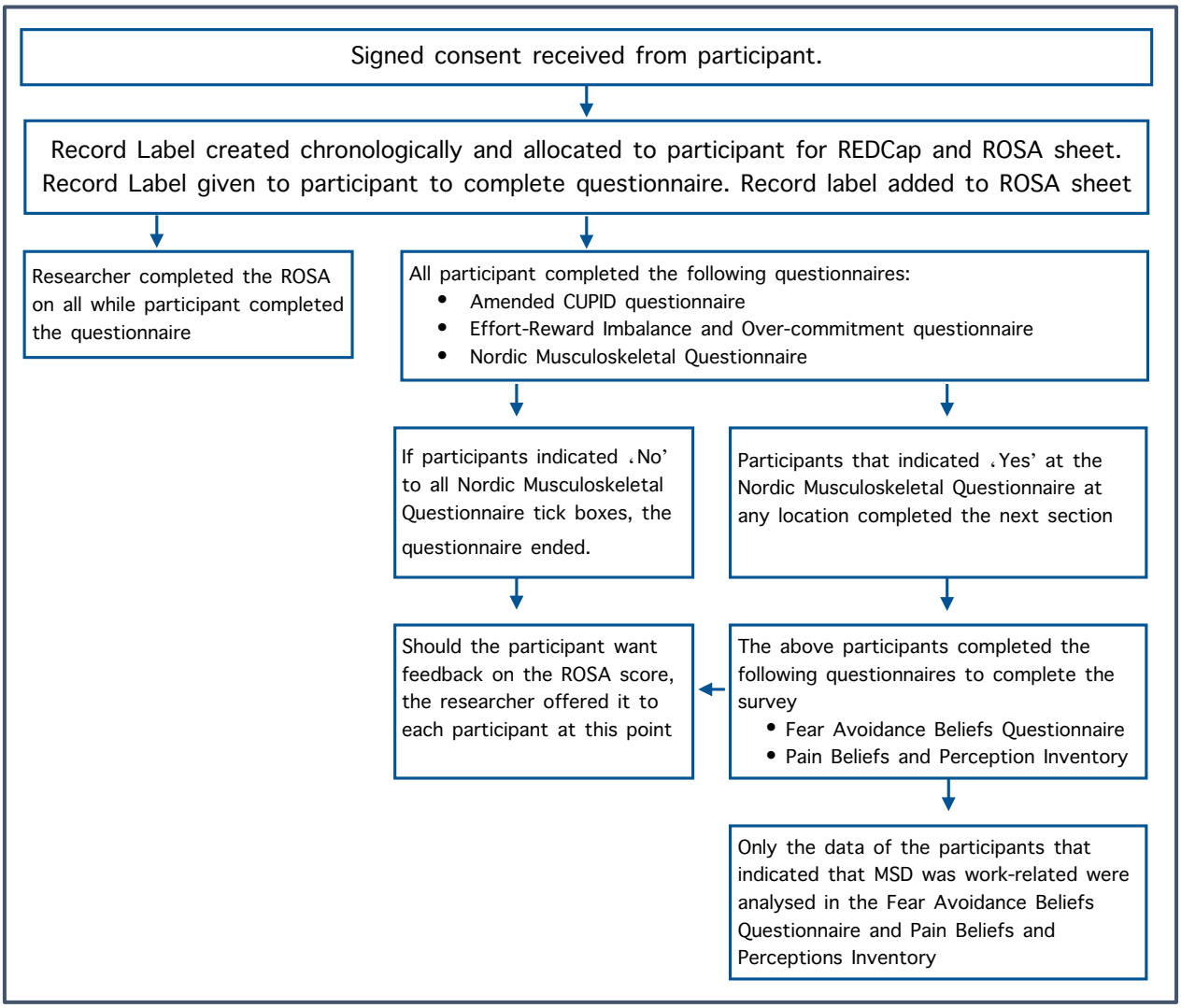


Figure 3. 2 Diagrammatic outline of data collection procedure

3.5 Ethical Considerations

Ethical clearance certificate M.171064 was obtained from the Human Research Ethics Committee (Medical) at the University of Witwatersrand (Appendix I). All participants signed informed consent forms prior to participating (Appendix A). All participants had the option to withdraw at any time without suffering any repercussions. Information

obtained from the participants was used only for the purpose intended for this study. Participants who indicated that they wished to receive unidentifiable results will be sent the final publication. To ensure confidentiality, only the study numbers of the participants were used throughout the study.

3.6 Data Analysis

Statistical Package for the Social Sciences Software (Version 25) was used in the analyses. All alpha levels were set to the 0.05 level. Missing data were not replaced and were thus ignored.

Statistical analysis related to Objective 1 involved both the MSD group and the reference group. Each variable was described in terms of its mean, standard deviation, median, range and frequencies in the MSD and the reference group respectively. The variables for individual demographics included age, height, BMI, sex, handedness, level of education, exercise frequency and average length of exercise sessions, the cut-off date when the last leave was taken, the average number of hours worked per week, as well as per day, and the computer/laptop combinations. In order to cater for all exercise regimes, the options of 'less than once a week' was given for individuals who may exercise sporadically but not as often as once a week, for example every 10 days. Differences between the categorical variables of the MSD group and the reference group were analysed using chi-squared tests. The ROSA score, the Effort-Reward Ratio, the effort and reward scores, the reward sub-scores (esteem, promotion or security), as well as the over-commitment scores were also included. Independent sampled t-tests, or Mann-Whitney U tests, where the assumptions of normality and homogeneity are violated, were run to determine whether there were differences between the mean variable scores for the MSD group and the reference group.

Objective 2 was to determine the relationship between effort, reward, over-commitment and the ergonomic risk factors in VDU users in the MSD group and the reference group. A two-tailed Pearson correlation was calculated to determine the relationships that exist in each group between the variables, namely ergonomic risk factors, effort, reward and over-commitment. Using a logistic regression model, two separate bivariate correlational (two-way) analyses were run to determine the relationships that exist between the variables of ergonomic risk factors, effort, reward, and over-

commitment. All outcomes which indicated a statistical significance were incorporated as independent variables in a stepwise binary logistic regression, with MSD categorisation as the dependent variable. A binary logistic regression model using the backward Wald method was used to further investigate which factors influenced the categorisation of the participants into the MSD group or the reference group.

Statistical analyses for the final three objectives were completed on the MSD group only. Objective 3 aimed to describe the type of MSD in VDU users with MSD on the basis of the Nordic Musculoskeletal Questionnaire and the associated pain beliefs using the FABQ and PBPI. The mean, standard deviation, and the score percentages for the FABQ and PBPI were then presented. The FABQ was analysed in terms of the two sub-scales, FABQ-PA and FABQ-W. The PBPI was also analysed in terms of the sub-scales, mystery, permanence, constancy and self-blame.

The fourth objective was to determine the differences between males and females in the MSD group. Independent sample t-tests were used to determine the differences between males and females in the MSD group in terms of the Effort-Reward Ratio, over-commitment, and the FABQ and PBPI scores.

The final objective was to determine the relationships between effort, reward, over-commitment, ergonomic risk factors, FABQ and PBPI in the MSD group. Analysis with Kendall's Tau-b was conducted to investigate the relationships between the different aspects of the MSD group.

3.7 Conclusion of the Methodology

In this chapter, the methods were described according to the STROBE guideline (von Elm *et al.*, 2014). The following chapter presents the results as described throughout this chapter.

CHAPTER 4: RESULTS

4.1 Study Participants

The results described below were concluded for 68 participants in the MSD group and 68 participants in the reference group. A total of 147 participants took part in the data collection process. Sampling stopped when no more willing participants were available on the data collection date, after statistical sample population was reached. Based on 'yes' tick boxes in any of the Nordic Musculoskeletal Questionnaire regions, and no other indication of any outside-related reason for MSD, 68 participants were grouped as MSD sufferers. The 68-strong reference group either had no MSD on the Nordic Musculoskeletal Questionnaire, or had indicated that MSD was related to injuries or incidents outside of work, (38 participants). Participants who did not complete the full data set, or asked to withdraw were excluded from the analysis, these were an additional 11 participants. The height of one participant and the weight of another in the reference group were not entered, and hence the respective BMIs of these two participants were not included in the analysis. (See Figure 4.1 for a diagrammatic representation of the MSD and reference group division.)

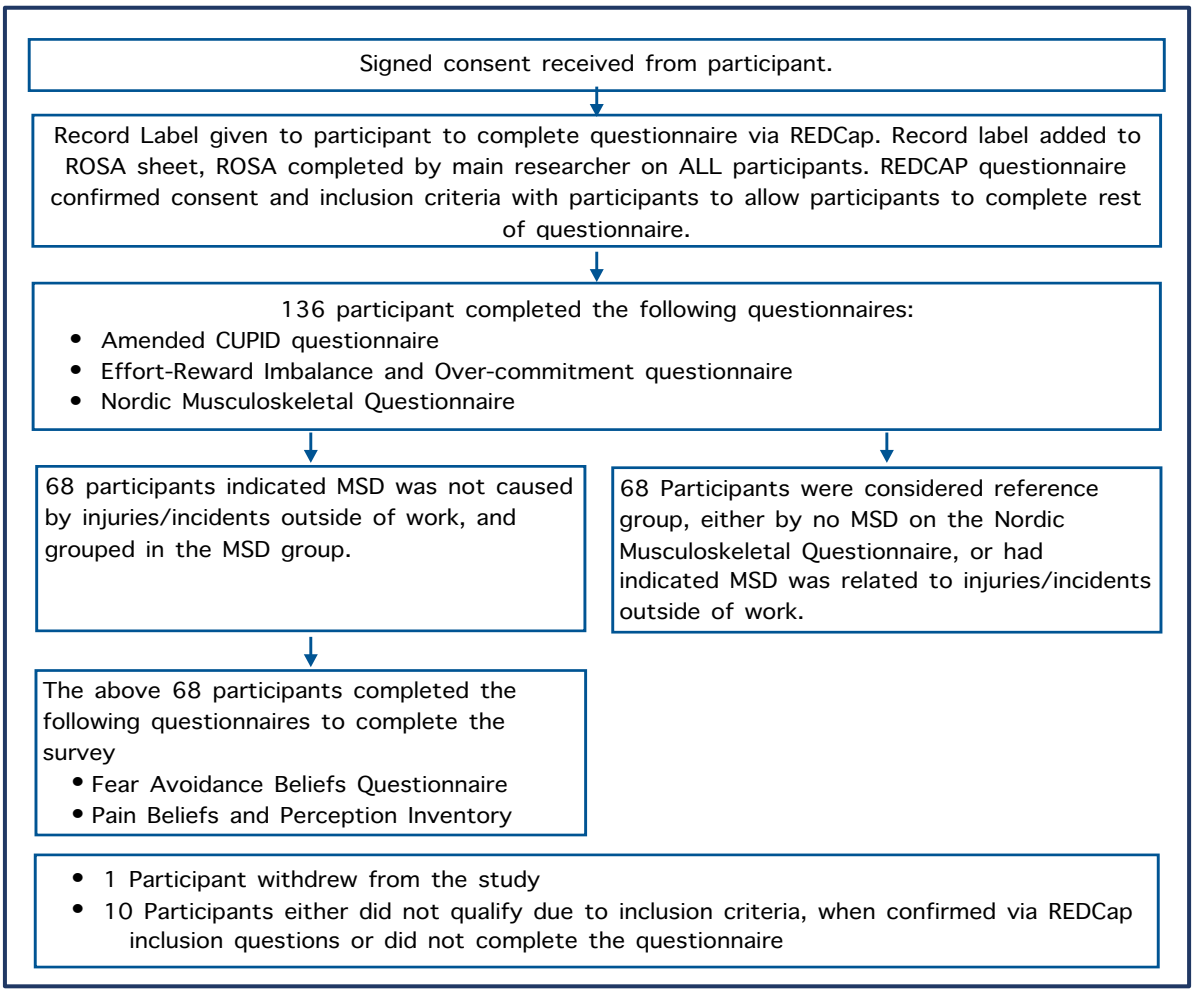


Figure 4. 1 Diagrammatic representation of MSD and reference group division

The following section describes the demographics, Effort-Reward Ratio, effort, reward, reward sub-scales, over-commitment and ergonomic risk factors in the MSD and reference group, as well as the differences between the MSD group and the reference group, in terms of Objective 1. This section also covers the second objective, namely to determine the differences between visual display unit users with MSD and those in a reference group in terms of individual demographics, the Effort-Reward Imbalance Model variables, over-commitment and ergonomic risk factors.

4.2 Objective 1: Differences between the MSD group and the reference group

The first objective was to describe the differences between the demographics, the Effort-Reward Imbalance Model variables, over-commitment and the ergonomic risk factors within each group. The first section reports on the individual demographics of the two groups as collected by the CUPID questionnaire. This is then followed by a section on the effort-reward imbalance and over-commitment, and finally, a report on

the ROSA final score, as well as sub-scores, concerning the ergonomic risk factors is presented.

4.2.1 Individual Demographics and Anthropometrics

The MSD group of 68 participants consisted of 45.6% (n=31) females and 54.4% (n=37) males. The reference group consisted of 68 participants, 39.7% (n=27) females and 60.3% (n=41) males. The handedness of the MSD group was 91.2% (n=62) right- and 8.8% (n=6) left-handed. On the other hand, the reference group consisted of 95.6% (n=65) right- and 4.4% (n=3) left-handed participants. No differences were found between the two groups in terms of sex (p=0.60) or handedness (p=0.49). (See Table 4.1 for the tabulated results concerning the demographics and anthropometrics, where no differences between the groups were found.) The mean for both groups in terms of BMI showed high values, thus indicating obesity.

Table 4. 1 Demographics and anthropometrics of the two groups

	MSD group Mean ± SD		**Reference group Mean ± SD**	**p value**
Age (years) (n=68)	33.3 ±8.5	**Age (years) (n=68)**	35.3 ±8.7	0.16
Height (m) (n=68)	1.7 ±0.1	**Height (m) (n=66)**	1.7 ±0.1	0.99
Weight (kg) (n=68)	75.9 ±15.7	**Weight (kg) (n=67)**	75.3 ±13.6	0.78
BMI (kg/m^2) (n=68)	26.1 ±5.3	**BMI (kg/m^2) (n=66)**	26.1 ±4.9	0.97

MSD = Musculoskeletal Disorders; BMI = Body Mass Index; SD = Standard Deviation; Number of data points for each variable differs on account of missing data.

4.2.2 Age at which Participants had completed Full-time Education

Table 4.2 below represents the distribution of the participants' ages at which they completed their full-time educational studies. There were no statistical differences between the two groups in terms of the age at which the participants completed their full-time education (p=0.81). The highest percentage of participants completed their full-time education between the ages of 19 and 22, and was 44.1% (n=30) in the MSD group and 50% (n=34) in the reference group.

Table 4. 2 Number of participants per age category who completed full-time education in the MSD group (n=68) and in the reference group (n=68)

	MSD group (%) (n)	**Reference group (%) (n)**	**p value**
16- 18 years	16.2 (11)	19.1 (13)	0.81
19-22 years	44.1 (30)	50.0 (34)	
23-26 years	30.9 (21)	26.5 (18)	
27-31 Years	5.9 (4)	2.9 (2)	
32-36 years	2.9 (2)	1.5 (1)	
37 years or older	0.0 (0)	0.0 (0)	

MSD = Musculoskeletal Disorders

4.2.3 Exercise Frequency and Duration

The information regarding the frequency of exercise sessions per week for the two groups is presented below in Table 4.3. Notably, in the reference group, 16.2% (n=11) of the participants did not exercise at all. The MSD group had only 4.4% (n=3) of its participants not exercising at all. Most of the MSD group (47.1%; 32 participants) exercised between one to three times per week. There was a significant statistical difference between the frequency of exercise sessions per week, as an entire variable, not within categories (p=0.02). (See Table 4.3 for exercise frequency per week.)

Table 4. 3 Frequency of exercise sessions per week in the MSD group (n=68) and in the reference group (n=68)

	MSD group (%) (n)	**Reference group (%) (n)**	**p value**
None	4.4 (3)	16.2 (11)	0.02
<1/week	26.5 (18)	14.7 (10)	
1-3/week	47.1 (32)	32.4 (22)	
4-5/week	17.6 (12)	30.9 (21)	
6-7/week	4.4 (3)	5.9 (4)	

MSD = Musculoskeletal Disorders

The majority of the members in the MSD group and in the reference group exercised for 30 to 60 minutes per week, with the respective percentages being 55.9% and 52.9%. (The average length of time spent exercising in each session is presented in Table 4.4.) There was no statistical difference between the two groups in respect of the average length of time spent exercising (p=0.94).

Table 4. 4 Duration of exercise sessions in the MSD group (n=68) and in the reference group (n=68)

	MSD group (%)(n)	Reference group (%)(n)	p value
Less than 30 minutes	35.3 (24)	36.8 (25)	0.94
30-60 minutes	55.9 (38)	52.9 (36)	
More than 60 minutes	8.8 (6)	10.3 (7)	

MSD = Musculoskeletal Disorders

4.2.4 Recent Leave taken by the MSD Group and the Reference Group

The leave taken in each group is presented below in Table 4.5. The table reveals a good distribution of leave taken over the previous six months. Only one participant, belonging to the MSD group, had last taken leave over a year before. Although the MSD group almost doubled the reference groups' percentage of participants that had taken leave in the previous four-week period, the difference was made up for over the four-to-eight week period, as well as over the two-to-six-month period. There was no statistical difference between the groups (p=0.22).

Table 4. 5 Frequency of the leave taken by the MSD group (n=68) and the reference group (n=68)

	MSD group (%) (n)	Reference group (%) (n)	p value
Previous 4 weeks	22.1 (15)	11.8 (8)	0.22
1-2 months previously	38.2 (26)	39.7 (27)	
2-6 months Previously	38.2 (26)	48.5 (33)	
> 1 year previously	1.5 (1)	0.0 (0)	

MSD = Musculoskeletal Disorders

4.2.5 Working Characteristics of the MSD Group and the Reference Group

The table below indicates that the sample population in both the MSD group and the reference group had a skewed distribution of staff, with the majority having worked for less than five years or more than ten. There was no statistical difference between the groups (p=0.49) in terms of years in formal employment. (See Table 4. 6 for a visual representation.)

Table 4.6 Years in formal employment for the MSD group (n=68) and the reference group (n=68)

	MSD group (%) (n)	Reference group (%) (n)	p value
1-5 years	44.1 (30)	34.3 (23)	0.49
6-10 years	11.8 (8)	16.4 (11)	
> 10 years	44.1 (30)	49.3 (33)	

MSD = Musculoskeletal Disorders

The duration of time spent working at the occupation was divided into 0 to 20 hours to indicate a half-day position, 21 to 40 hours for full-time workers, 40 to 50 hours for full-time workers with ten hours overtime, and more than 50 hours. The distribution of hours indicates that the majority of the sample group were employed full time, with only 1,5% (n=1) and 5,9% (n=4) working at half-day posts in the MSD group and the reference group respectively. There was no statistical difference between the groups with regard to the number of hours worked per week (p=0.34). Table 4.7 shows the duration of time spent at work per week by the MSD group and the reference group.

Table 4. 7 Duration of time in hours per week at occupation in the MSD group (n=68) and the reference group (n=68)

	MSD group (%) (n)	Reference group (%) (n)	p value
0-20 hours	1.5 (1)	5.9 (4)	0.34
21-40 hours	44.1 (30)	32.4 (22)	
40-50 hours	52.9 (36)	60.3 (41)	
More than 50 hours	1.5 (1)	1.5 (1)	

MSD = Musculoskeletal Disorders

The inclusion criterion to participate in the study was at least four hours using a VDU; and the duration of time spent using a VDU was the variable that was investigated. The distribution of VDU time, as presented in Table 4.8, is not surprising considering the work requirements as set out in Table 4.7, with the majority of both groups working with a VDU for between six and eight hours a day. There was no statistical difference between the groups (p=0.06). This is a marginally insignificant, individually-adjusted residual to indicate that the MSD group is more likely to have been classified into the four-to-six-hours group than into the reference group. Table 4.8 below presents the results for the MSD group and the reference group for time spent using a VDU in the work context.

Table 4. 8 Duration of time spent using a VDU in the MSD group (n=68) and in the reference group (n=68)

	MSD group (%) (n)	Reference group (%) (n)	P value
4-6 hours	16.2 (11)	4.4 (3)	0.06
6-8 hours	57.4 (39)	70.6 (48)	
More than 8 hours	26.5 (18)	25.0 (17)	

MSD = Musculoskeletal Disorders

Table 4.9 below indicates the variety of options and work-station requirements for various VDU work-station set ups. A quarter (n=17) of the reference group used a desktop computer only as opposed to only 11,8% (n=8) of the MSD group. There were slightly more employees in the MSD group (5.9%, n=4) who used an external keyboard with a laptop versus those in the reference group (1,5%. n=1). However, there was no statistical difference between the two groups (p=0.44) in terms of this variable.

Table 4. 9 Work-station VDU set-up of the MSD group (n=68) and the reference group (n=68)

	MSD group (%)(n)	Reference group (%)(n)	p value
Laptop	27.9 (19)	26.5 (18)	0.44
Laptop using an external keyboard	5.9 (4)	1.5 (1)	
Desktop	11.8 (8)	25.0 (17)	
One Desktop and one Laptop	14.7 (10)	10.3 (7)	
More than one Desktop and one laptop	1.5 (1)	1.5 (1)	
One Laptop with a Monitor	29.4 (20)	26.5 (18)	
One Laptop with two or more monitors	8.8 (6)	8.8 (6)	

MSD = Musculoskeletal Disorders

4.2.6 Effort-Reward Imbalance and Over-commitment Model

The following section reports on the differences between the MSD group and the reference group results in the effort-reward imbalance and over-commitment section. Table 4.10 shows the scale of effort, total reward, the Effort-Reward Ratio, the reward sub-scales and the over-commitment scores for the MSD group and the reference group respectively. The Effort-Reward Ratio for the MSD group, as well as for the reference group was calculated as less than one; hence there were fewer efforts than rewards. The over-commitment score was significantly different (p=0.041) where the MSD group earned a higher mean over-commitment score as opposed to the reference group. (See Figure 4.2 for a representation of the over-commitment of both

groups, where both groups shared the highest and lowest scores of 22 and seven respectively.)

Table 4.10 Effort-Reward Imbalance and Over-commitment in the MSD group (n=68) and the reference group (n=68)

		Range	MSD group Mean ± SD	Reference group Mean ± SD	p value
Effort-Reward Ratio		<1 or 1>	0.9 ±0.2	0.9 ±0.2	0.29
Effort		6-24	15.6 ±3.0	14.8 ±2.3	0.12
Total Reward		10-40	30.9 ±3.9	30.8 ±3.7	0.89
Reward Sub-scales	**Reward-Esteem**	4-16	9.6 ±1.4	9.6 ±1.3	0.79
	Reward-Promotion	4-16	11.8 ±1.9	11.4 ±1.7	0.59
	Reward-Security	2-8	6.4 ±1.0	6.4 ±1.2	0.88
Over-commitment		6-25	14.9 ±3.1	13.8 ±3.4	0.04

MSD = Musculoskeletal Disorders; SD = standard deviation

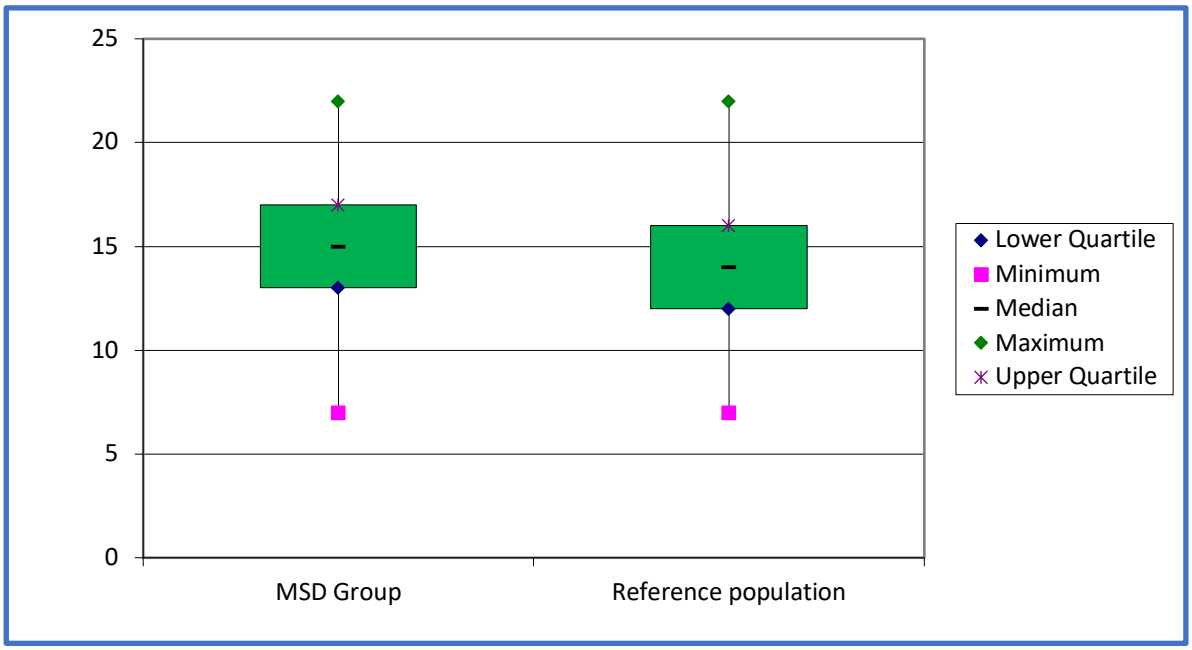


Figure 4. 2 Over-commitment scores for the MSD group (n=68) and the reference group (n=68)

4.2.7 Rapid Office Strain Assessment Results

The ergonomic risk factors were assessed via the ROSA. The ROSA scores from both the MSD group and the reference group were under five. According to Sonne *et al.,* (2012), a score of five warrants immediate action, and requires work-station adjustment. A lower score does not indicate a risk, but if a large-scale office intervention is planned, the risk score of five or more allows one to prioritise risk. The

mean final ROSA scores for the MSD group and the reference group were 4.5 ±1.0 and 4.3 ± 0.8 (p=0.10) respectively.

Table 4.11 shows the number of participants in the MSD group and the reference group in each ROSA final score grouping. Both groups had 29 participants with a score of five. Only the MSD group had participants (n=2) with a final score of seven. Not one participant scored less than three or more than eight. (Table 4.12, Table 4.13 and Table 4.14 show the sub-scores of the ROSA.)

Table 4. 11 Final ROSA Score for MSD group (n=68) and the reference group (n=68)

Score	MSD group (%)(n)	Reference group (%)(n)
1	0.0 (0)	0.0 (0)
2	0.0 (0)	0.0 (0)
3	20.6 (14)	23.5 (16)
4	23.5 (16)	30.9 (21)
5	42.7 (29)	42.7 (29)
6	10.3 (7)	2.9 (2)
7	2.9 (2)	0.0 (0)
8	0.0 (0)	0.0 (0)
9	0.0 (0)	0.0 (0)
10	0.0 (0)	0.0 (0)

MSD = Musculoskeletal disorders

Table 4.12 ROSA Section A: the MSD group (n=68) and the reference group (n=68)

	MSD (%) (n)	Ref (%) (n)	MSD (%) (n)	Ref (%) (n)	MSD (%) (n)	Ref (%) (n)
	Seat pan/height/depth		**Arm rest/back support**		**Section A: Chair**	
1	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
2	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	10.3 (7)	13.2 (9)
3	69.1 (47)	72.1 (49)	17.7 (12)	16.2 (11)	29.4 (20)	30.9 (21)
4	10.3 (17)	20.6 (14)	23.5 (16)	30.9 (21)	32.3 (22)	38.2 (26)
5	0.0 (0)	4.4 (3)	35.3 (24)	36.8 (25)	17.7 (12)	16.2 (11)
6	1.5 (1)	2.9 (2)	17.6 (12)	16.2 (11)	7.4 (5)	1.5 (1)
7	4.4 (3)	0.0 (0)	5.9 (4)	0.0 (0)	2.9 (2)	0.0 (0)
8	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
9	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
10	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)

MSD = Musculoskeletal disorder group; Ref = reference group

Table 4. 13 ROSA Section B: the MSD group (n=68) and the reference group (n=68)

	MSD (%) (n)	Ref (%) (n)	MSD (%) (n)	Ref (%) (n)	MSD (%) (n)	Ref (%) (n)
	Monitor		**Phone**		**Section B**	
1	0.0 (0)	0.0 (0)	100 (68)	97.1 (66)	23.5 (16)	26.5 (18)
2	10.3 (17)	27.9 (19)	0.0 (0)	1.5 (1)	32.3 (22)	35.3 (24)
3	30.9 (21)	33.9 (23)	0.0 (0)	1.5 (1)	42.7 (29)	35.3 (24)
4	42.7 (29)	36.8 (25)	0.0 (0)	0.0 (0)	1.5 (1)	2.9 (2)
5	1.5 (1)	1.5 (1)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
6	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
7	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
8	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
9	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
10	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)

MSD = Musculoskeletal disorder Group; Ref = reference group

Table 4.14 ROSA Section C: the MSD group (n=68) and the reference group (n=68)

	MSD (%) (n)	Ref (%) (n)	MSD (%) (n)	Ref (%) (n)	MSD (%) (n)	Ref (%) (n)
	Mouse		**Keyboard**		**Section C**	
1	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
2	13.2 (9)	13.2 (9)	29.4 (20)	33.9 (23)	0.0 (0)	0.0 (0)
3	60.3 (41)	50.0 (34)	44.1 (30)	29.4 (20)	52.9 (36)	45.6 (31)
4	26.5 (18)	36.8 (25)	22.1 (15)	33.9 (23)	11.8 (8)	20.6 (14)
5	0.0 (0)	0.0 (0)	4.4 (3)	2.9 (2)	32.3 (22)	32.3 (22)
6	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	2.9 (2)	1.5 (1)
7	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
8	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
9	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
10	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)

MSD = Musculoskeletal disorder Group; Ref = reference group

No comparison between sub-scores was undertaken as only the final ROSA score was validated. However, the sub-scores are presented to allow for discussion.

4.3 Objective 2: Relationships between variables in the MSD group and the reference group

No significant relationships were found between the ROSA scores and the effort, reward and over-commitment measures in the MSD group. The MSD group results revealed the following significant correlations. Both reward, and reward promotion had negative, weak correlations with effort, namely $r = -0.271$, $p = 0.05$, and $r = -0.259$, $p = 0.005$, respectively. There was a positive but weak correlation ($r = 0.487$, $p = 0.01$) between effort and over-commitment. By nature, the effort and reward of the Effort-Reward Imbalance Model would be negatively associated. Over-commitment and

reward security had a weak, negative correlation, (r = -0.251, p = 0.05). By nature, total reward, as well as the reward sub-scales, were found to be strongly and positively associated as the sub-scales are derived from the total reward. (The relationships between the variables of the ergonomic risk factors in the MSD group, namely effort, reward and over-commitment, are displayed in Table 4.15 below.)

Table 4. 15 Relationship between factors in the MSD group (n=68)

		ROSA	Effort	Reward	Reward esteem	Reward Promotion	Reward security	Over-commitment
ROSA		1						
Effort		0.136	1					
Total Reward		-0.077	-0.271*	1				
Reward sub-scales	**Reward-Esteem**	-0.088	-0.228	0.856**	1			
	Reward-Promotion	-0.123	-0.259*	0.874**	0.571**	1		
	Reward-Security	0.088	-0.162	0.721**	0.503**	0.478**	1	
Over-commitment		-0.018	0.487**	-0.202	-0.188	-0.108	-0.251*	1

*Correlation is significant at the 0.05 level (two-tailed)

** Correlation is significant at the 0.01 level (two-tailed). ROSA = Rapid Office Strain Assessment

No significant relationships were found between the ROSA scores and the effort, reward and over-commitment measures in the reference group. The significant relationships in the reference group were as follows: effort and reward, and effort and reward security - both showed weak, negative correlations, namely r = -0.371, p = 0.01, and r = -0.435, p = 0.01, respectively. Effort and reward promotion showed a weak negative correlation (r = -0.270, p = 0.01). Effort and over-commitment showed a moderate positive correlation (r = 0.570, p = 0.01). By nature, the effort and reward of the Effort-Reward Imbalance Model would be negatively associated. Over-commitment and reward showed a weak negative correlation, (r = -0.365, p = 0.01), as did both reward and esteem (r = -0.308, p = 0.01) and reward and security (r = -0.357,

p = 0.01). Over-commitment and reward promotion showed a weak negative correlation (r = -0.239, p = 0.05). The total reward, as well as the reward sub-scales, were expected, by nature, to be strongly and positively associated since the sub-scales are derived from the total reward. (The relationships between the variables of the ergonomic risk factors, effort, reward and over-commitment in the reference group are displayed in Table 4.16 below.)

Table 4. 16 Relationship between factors in the reference group (n=68)

		ROSA	Effort	Reward	Reward esteem	Reward Promotion	Reward security	Over-commitment
ROSA		1						
Effort		-0.079	1					
Total Reward		0.149	-0.371**	1				
Reward sub-scales	**Reward-Esteem**	0.219	-0.233	0.823**	1			
	Reward-Promotion	0.083	-0.270*	0.858**	0.571**	1		
	Reward-Security	0.041	-0.435**	0.714**	0.503**	0.478**	1	
Over-commitment		-0.119	0.570**	-0.365**	-0.308*	-0.239*	-0.357**	1

*Correlation is significant at the 0.05 Level (two-tailed).

** Correlation is significant at the 0.01 level (two-tailed); ROSA = Rapid Office Strain Assessment

The variables included in the model to predict categorisation were over-commitment,- owing to its statistical significance (discussed and illustrated above in Figure 4.2), as well as the socio-demographic variables detailed in the first section. The logistic regression model generated was statistically significant, X2(3)=14.584, p=0.002, with a Nagelkerke R Square value of 0.136 indicating that the model accounted for 13.6% of the variance in group categorisation. The model was stronger at identifying individuals within the MSD group (percentage correct = 75%) compared to the reference group (51.5%), with an average correct classification percentage of 63.2%. (The model generated is illustrated below, in Table 4.17 and Table 4.18.)

From the model generated, participants showing high levels of over-commitment were members of the MSD group. Furthermore, individuals who were not exercising at all were 4.49 times more likely to be members of the reference group. Those exercising

four to five times per week were 2.47 times more likely to be in the reference group. None of the other levels of physical activity was found to be a statistically significant predictor in this model.

Table 4. 17 Model for categorisation into the MSD group (n=68)

Predictor	B	S.E.	Wald.	df	Sig.	Exp.(B)	95% C.I. for Exp. (B)	
Over-commitment	-0.112	0.056	3.931	1	0.05	0.894	0.8	0.999
No Physical Activity/week	1.746	0.629	5.703	1	0.01	4.49	1.309	15.404
Physical Activity 4-5 times/week	0.884	0.43	4.436	1	0.04	2.472	1.065	5.74
Constant	1.216	0.838	2.082	1	0.149	3.353		

B = unstandardised beta coefficient; S.E = Standard Error; df = Degrees of Freedom; Sig. = Significance; C.I = Confidence Interval; Exp = Exponentiation

Table 4. 18 Model for categorisation into the MSD group (n=68)

	B	S.E.	Wald	df	Sig.	Exp(B)
No physical activity			9.782	4	0.044	
Physical activity once/week	-1.682	0.708	5.642	1	0.018	0.186
Physical activity 1-3 times/week	-1.510	0.655	5.309	1	0.021	0.221
Physical activity 4-5 times/week	-0.598	0.698	0.734	1	0.392	0.550
Physical activity 6-7 times/week	-0.730	0.978	0.557	1	0.456	0.482
Over-commitment	-0.113	0.057	3.907	1	0.048	0.893
Constant	2.724	1.053	6.696	1	0.010	15.238

B = unstandardised beta coefficient; S.E = Standard Error; df = Degrees of Freedom; Sig. = Significance; Exp = Exponentiation

Further testing was undertaken to establish whether the Effort-Reward Ratio and/or the ROSA could be considered as predictors for grouping. In fact, Table 4.19 indicates that neither of the two variables can be considered to predict membership of a group.

Table 4.19 Model for the Effort-Reward Ratio and the ROSA as predictors for grouping

	B	S.E.	Wald	df	Sig.	Exp(B)
Age	0.035	0.024	2.083	4	0.149	1.036
Height	-1.681	2.134	0.621	1	0.431	0.186
Weight	-0.006	0.014	0.184	1	0.668	0.994
Sex	0.497	0.474	1.103	1	0.294	1.644
ROSA	-0.245	0.211	1.343	1	0.246	0.783
Effort-Reward Ratio	-1.156	0.875	1.747	1	0.186	0.315
Constant	3.931	4.096	0.921	1	0.337	50.972

B = unstandardised beta coefficient; S.E = Standard Error; df = Degrees of Freedom; Sig. = Significance; ROSA = Rapid Office Strain Assessment; Exp = Exponentiation

4.4 Objective 3: Type of MSD

The MSD group indicated the site/location of MSD through screening with the Nordic Musculoskeletal Questionnaire.

4.4.1 Twelve-month Prevalence of MSD by Site/Location

The highest prevalence remains in the neck region at n=47 (69.1%) and the lowest with the elbow and ankle, both at n=4. (Figure 4.3 graphically represents prevalence by site/location.)

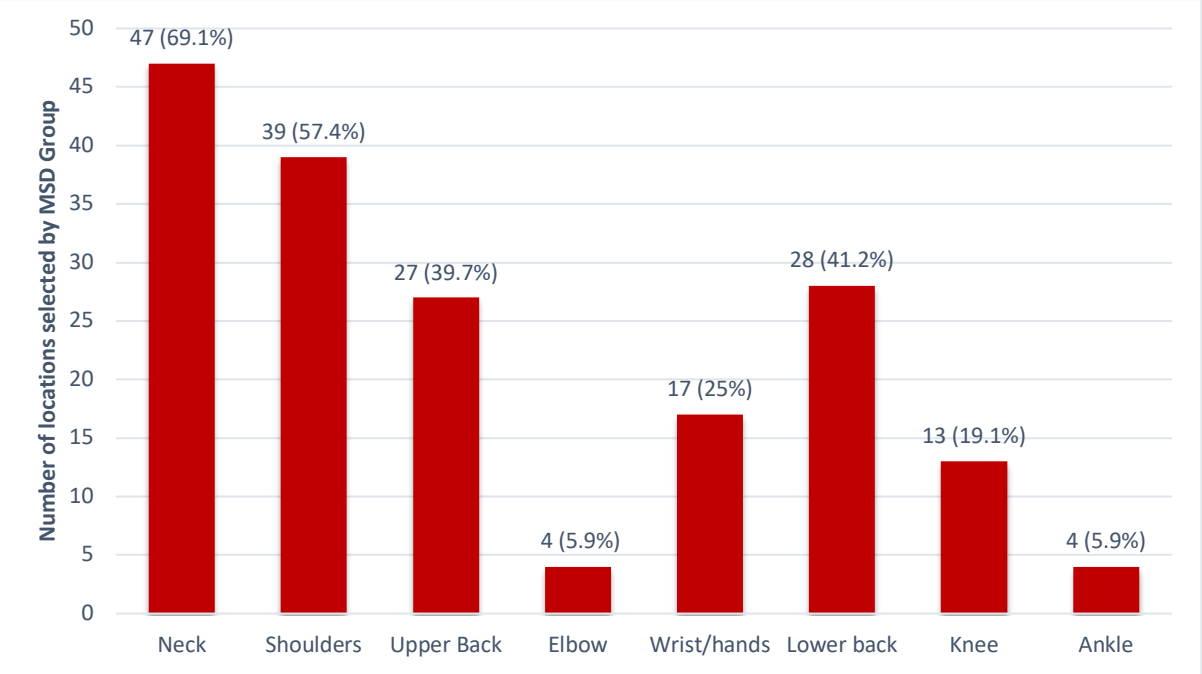


Figure 4. 3 Twelve-month Prevalence of MSD by Site/Location (n=68)

Participants could select more than one site/location of MSD. Multiple sites of pain are presented in section 4.4.5.

4.4.2 MSD affecting Function over the previous Twelve Months

Although the prevalence rates were high, 49 participants indicated that the MSD that they suffered from did not affect function. (See Figure 4.4.)

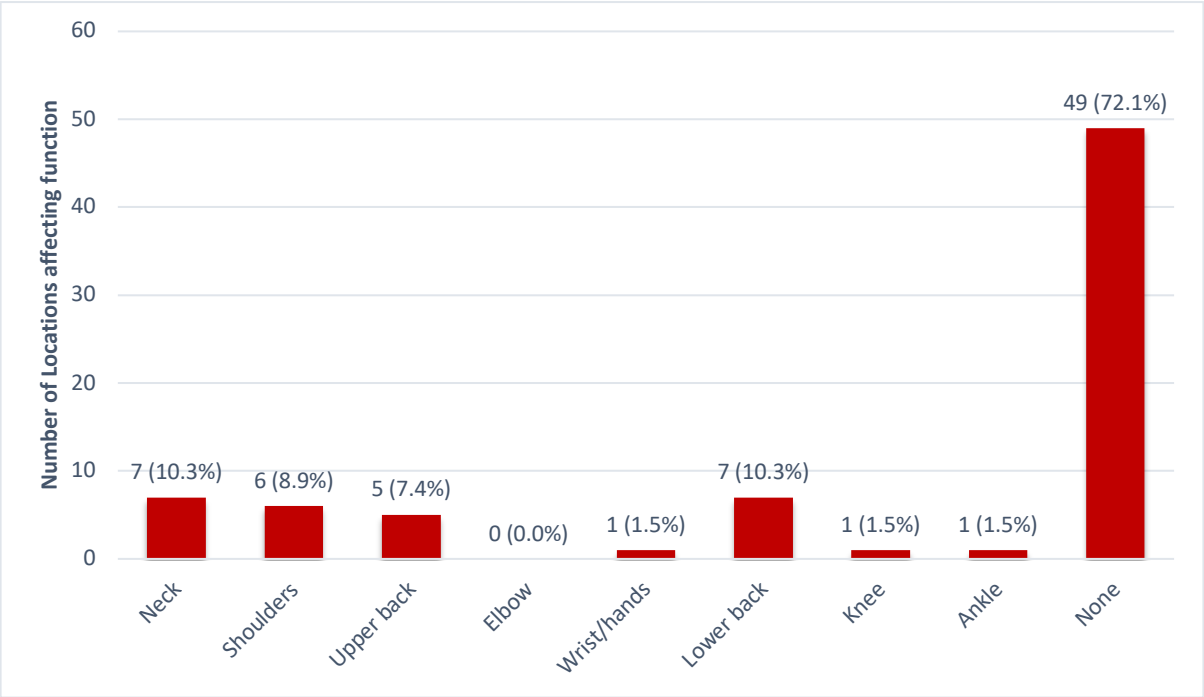


Figure 4. 4 MSD affecting Function over the previous 12 months (n=68)

Participants could select more than one site/location, as more than one site/location could be selected in the previous question.

4.4.3 MSD that resulted in Participants seeking Medical Consultation

As seen in Figure 4.5, 50 participants indicated that the MSD that they suffered from did not result in attempts to seek medical attention. One can note that the categories that have higher rates of prevalence, such as the neck, shoulder and upper back, also have the highest rates respectively for attempts to seek medical attention.

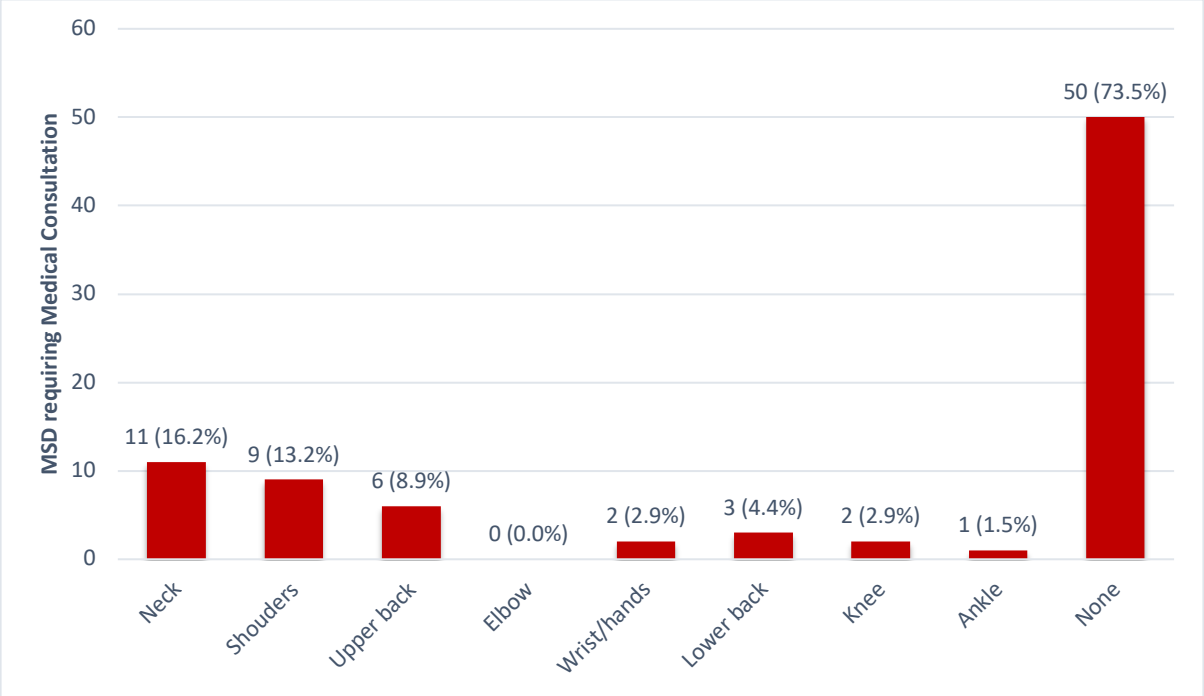


Figure 4. 5 The site/location of MSD that resulted in Participants seeking Medical Consultation (n=68)

Participants could select more than one site/location, as more than one site/location could be selected in the first question.

4.4.4 Prevalence of MSD in the previous Seven Days

Generally, comparing the seven-day to 12-month prevalence percentages, the seven day prevalence resulted in a more even distribution of areas, as well as lower percentages as a whole. As with the 12-month prevalence, the neck region presented with the highest prevalence (n=23), followed by the shoulders, (n=19). Unlike the 12-month prevalence, upper back prevalence (n=11) scored higher than the lower back prevalence (n=9). Both the 12-month and seven-day prevalence categories share the same top four sites/locations for MSD. (See Figure 4.6.)

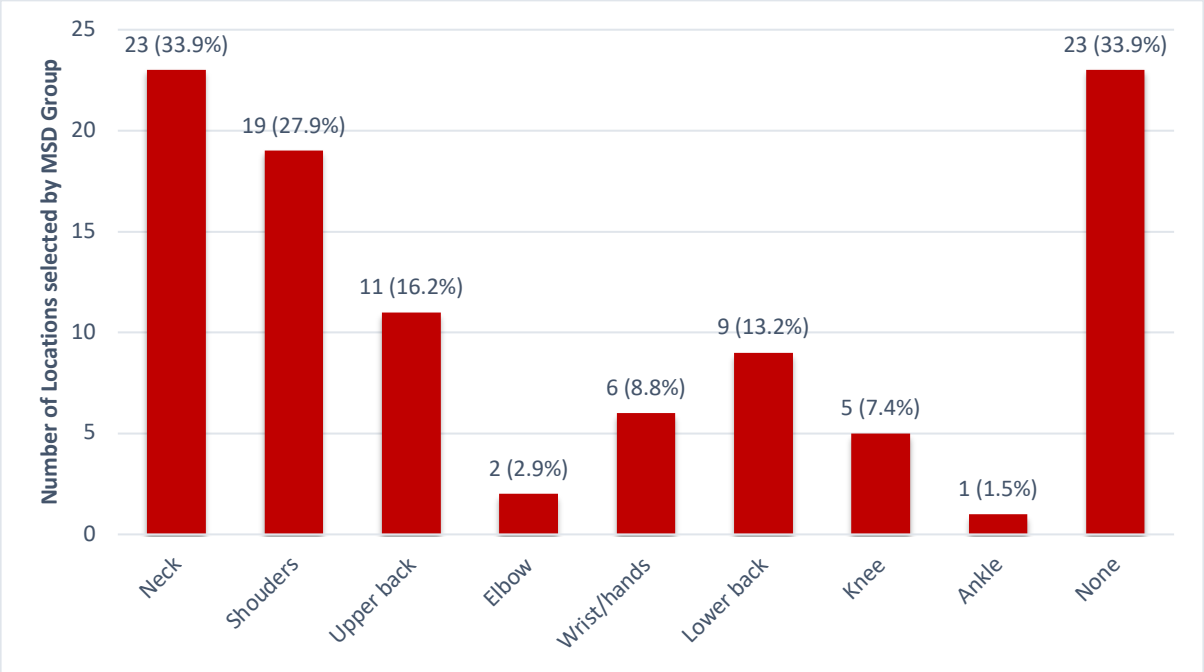


Figure 4. 6 Prevalence of MSD in the previous Seven Days (n=68)

Participants could select more than one site/location as more than one site/location could be affected by MSD.

4.4.5 Multi-site MSD

Participants could indicate more than one site of MSD. This is known as multi-site MSD. The MSD group in this research study experienced a mean score for multi-site MSD of 2.6 ±1.4, with Table 4.20 indicating the frequency of participants experiencing MSD in one or more sites.

Table 4. 20 Number of Participants in the MSD group experiencing multi-site pain (n=68)

Number of Sites	Participants experiencing pain in one or more sites (%)(n)
1	22.1 (15)
2	32.4 (22)
3	23.5 (16)
4	8.8 (6)
5	10.3 (7)
6	1.5 (1)
7	1.5 (1)

MSD = Musculoskeletal Disorders

4.5 Pain Beliefs amongst participants in the MSD group

The MSD group completed the FABQ and PBPI to establish whether they held any altered pain beliefs.

Table 4.21 shows the FABQ-W, FABQ-PA and PBPI sub-scores. The FABQ-W has a total range of 0 to 42, where a score above 29/42 indicates a risk for poor outcomes in treatment. The FABQ-PA has a range of 0 to 24, where a score above 13/24 is regarded as an indication of poor outcomes in treatment. The participants presented with median scores well below the cut-off scores for the FABQ-W and FABQ-PA. The PBPI scores could range from a negative two (-2) through to a positive two (+2), where a positive score indicates endorsement of the belief. The negative mean scores of all the PBPI sub-scores indicate that the participants did not endorse their pain beliefs. By these values, one could draw the conclusion that the VDU population does not present with altered pain beliefs.

Table 4. 21 Descriptive Statistics of FABQ and PBPI (n=68)

Questionnaire	Mean ± SD	Minimum of group	Maximum of group
FABQ-W	6.5 ±5.4	0	21
FABQ-PA	7.9 ±6.3	0	20
PBPI Mystery	-1.1 ±0.7	-2	0
PBPI Permanence	-1.2 ±0.7	-2	1.25
PBPI Constancy	-1.1 ±0.7	-2	0.50
PBPI Self-blame	-1.2 ±0.6	-2	0

FABQ-W = Fear Avoidance Beliefs Questionnaire- Work; FABQ-PA= Fear Avoidance Beliefs Questionnaire- Physical Activity; PBPI = Pain Beliefs Perception Inventory; SD = Standard Deviation

Figure 4.7, a histogram, indicates that only nine participants had scores higher than 12 on the FABQ-W subscale.

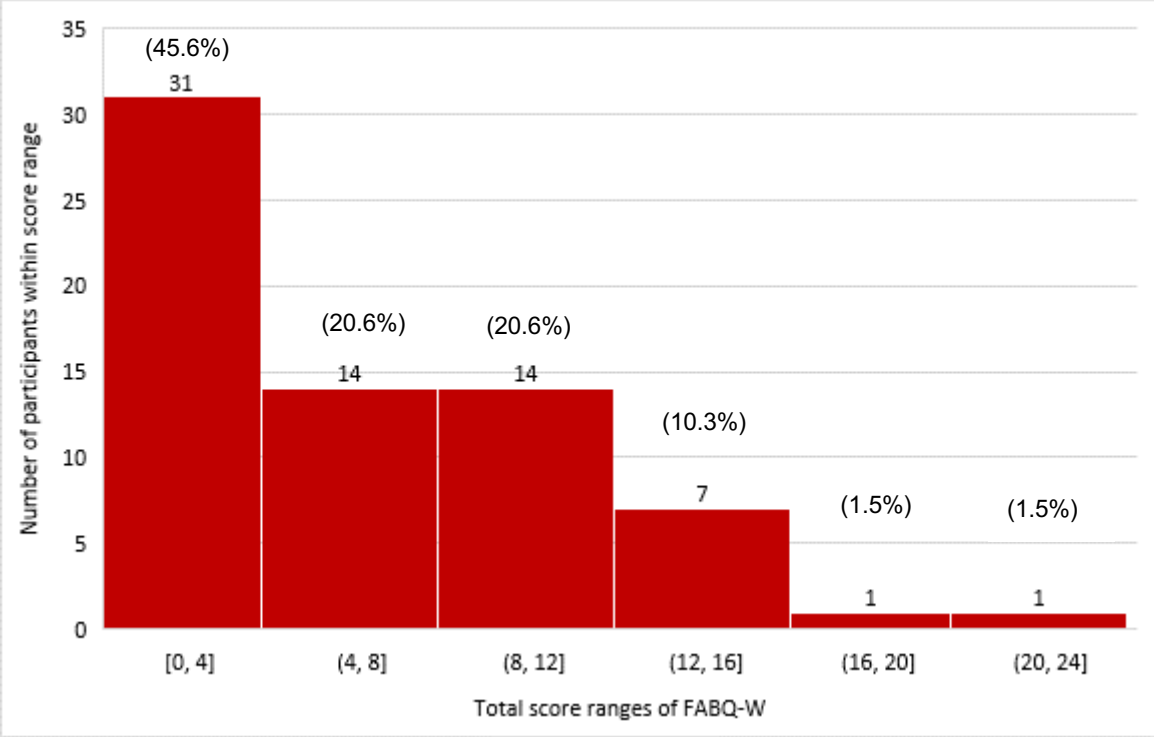


Figure 4. 7 Distribution of FABQ-W Scores

Values at the bottom of the graph indicate the range of the sub-score, and the data labels the number of participants who scored within that range. Bin ranges are rounded up to the nearest whole number in the figure, however the range ends at last increment before the whole number, eg. 3.99.

The MSD group had16 participants that achieved scores of 13 and above, which is said to be indicative of a poor outcome on the FABQ-PA subscale. The rest of the MSD group (n=52) had scores of 12 or less. As such, their fear-avoidance beliefs do not influence outcome. (Figure 4.8, a histogram illustrates these findings.)

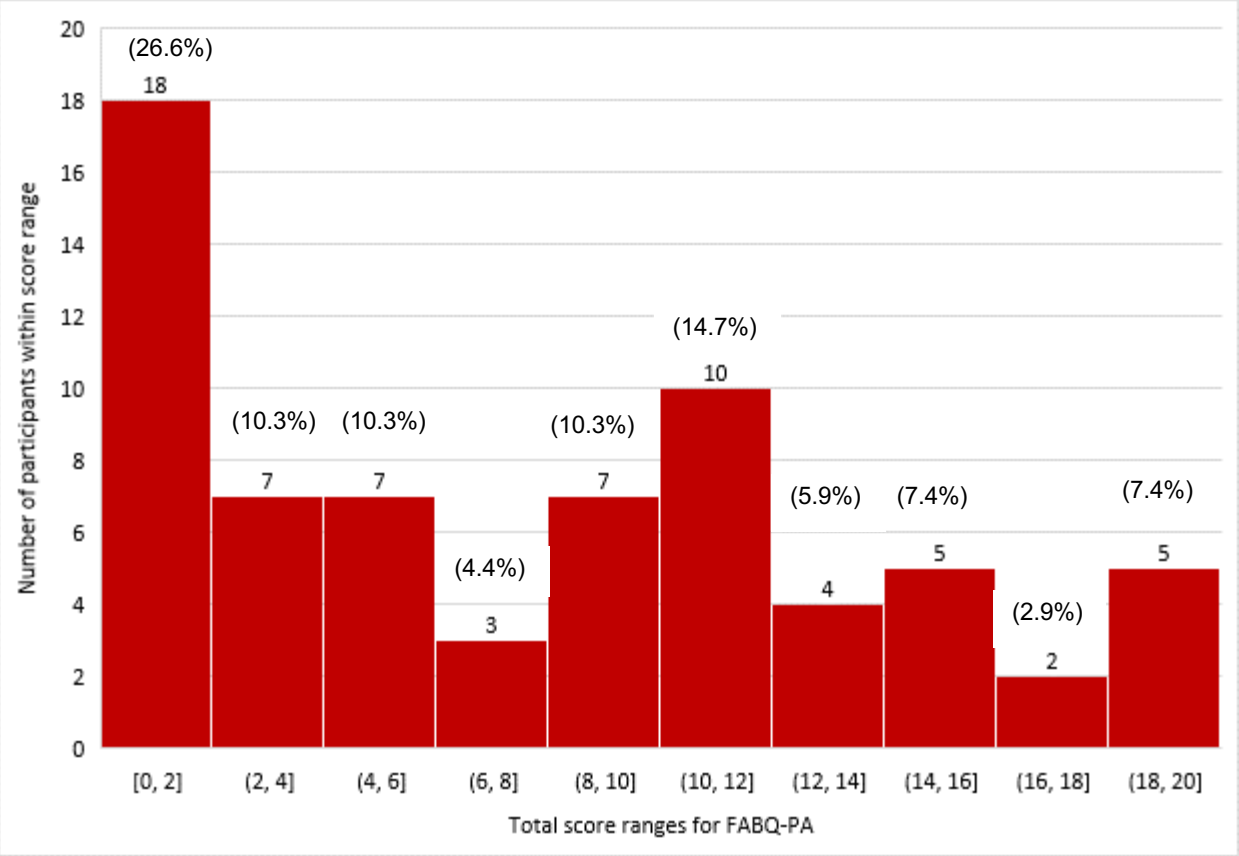


Figure 4. 8 Distribution of FABQ-PA Scores

Values at the bottom of the graph indicate the range of the sub-score, and the data labels the number of participants that scored within that range. Bin ranges are rounded up to the nearest whole number in the figure, however the range ends at last increment before the whole number, eg. 2.99; 3.99; 5.99

The mystery sub-score in the PBPI indicates that none of the VDU users in this MSD group believes that pain is mysterious. This can be seen in the distribution of the scores in the negative section of Figure 4.9.

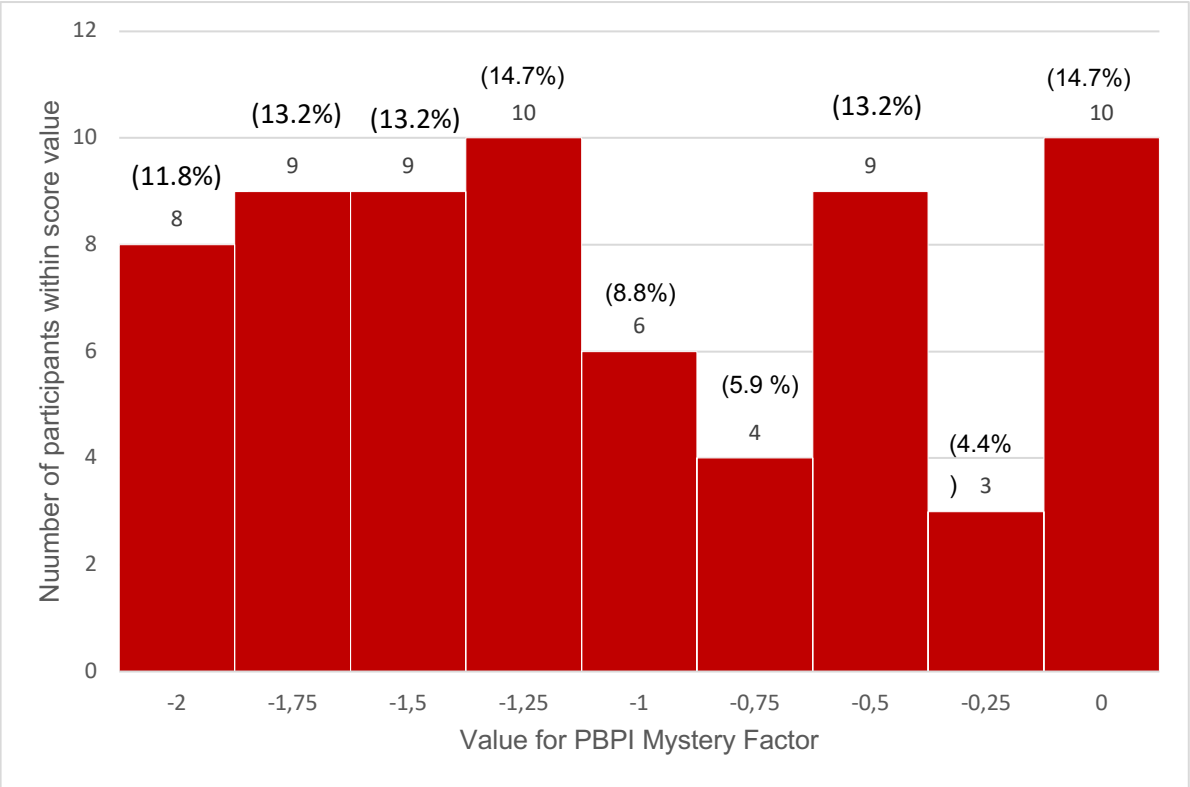


Figure 4. 9 Distribution of the PBPI Mystery Factor

Values at the bottom of the graph indicate the range of the sub-score, and the data labels the number of participants that scored within that value.

The permanence sub-score in the PBPI indicates that only five of the VDU users in this MSD group believe in the permanence of pain. Even these five scores are not higher than 1,25. (Figure 4.10 shows the distribution of scores.)

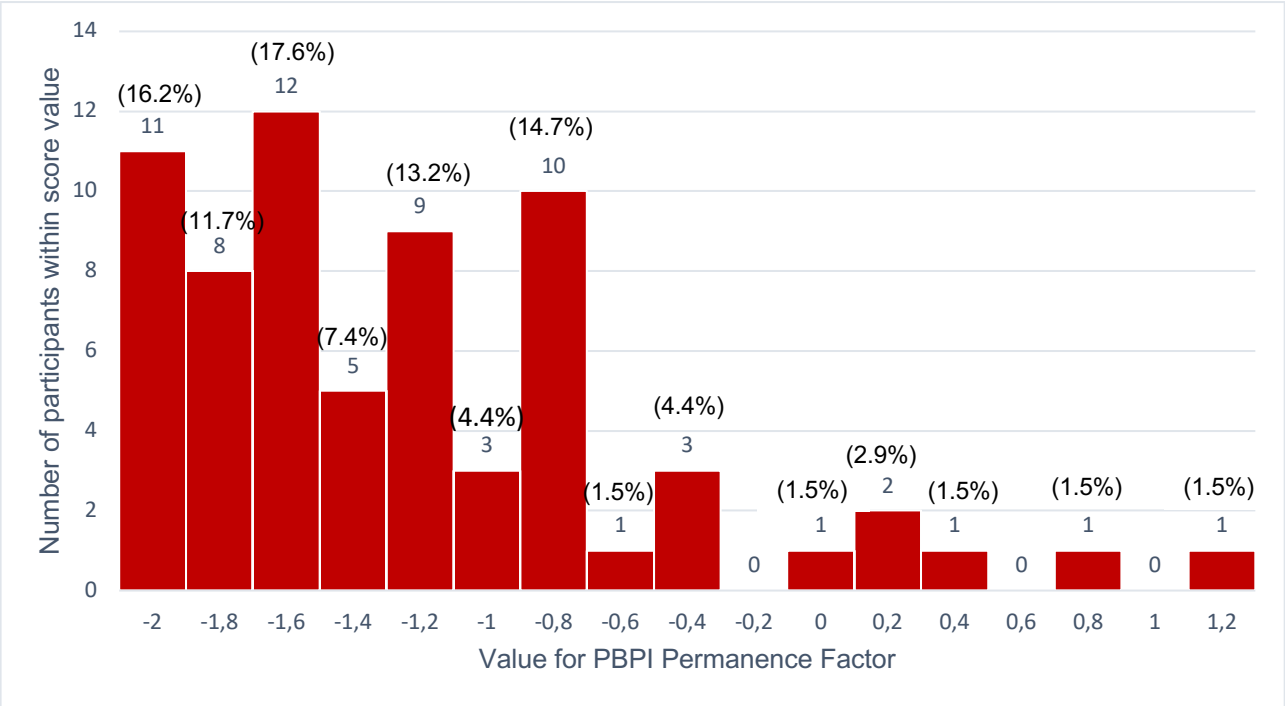


Figure 4. 10 Distribution of PBPI Permanence Scores

Values at the bottom of the graph indicate the value of the sub-score, and the data labels the number of participants that scored within that value.

(7.4%)

The constancy sub-score in the PBPI indicates that seven of the VDU users in this MSD group believe in the constancy of pain (Figure 4.11). The maximum score of 0.5, was obtained by one participant. The others in this MSD group do not hold this belief.

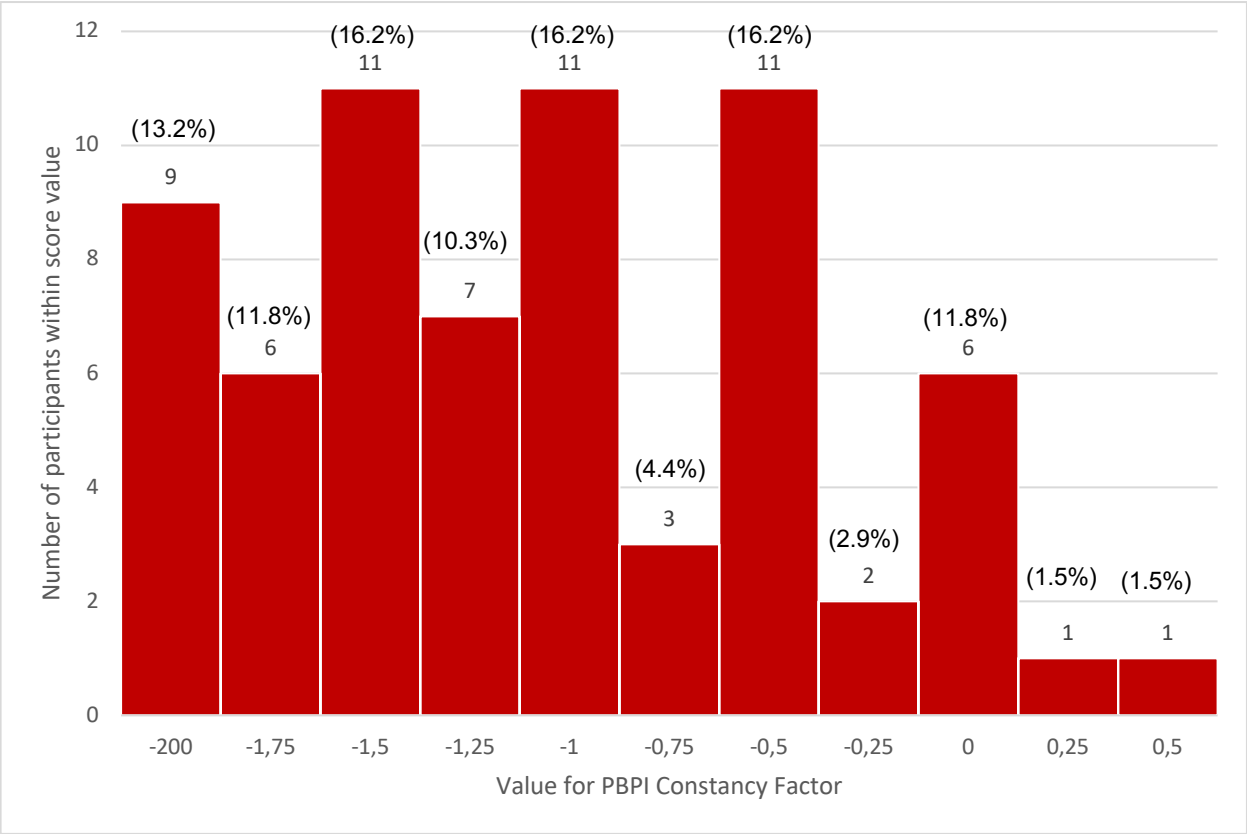


Figure 4. 11 Distribution of PBPI Constancy Scores

Values at the bottom of the graph indicate the value of the sub-score, and the data labels the number of participants that scored within that value.

Not one participant indicated a belief in self-blame. All participants' scores were under zero. There is, therefore, no endorsement of this belief. Figure 4.12 shows no values in the positive.

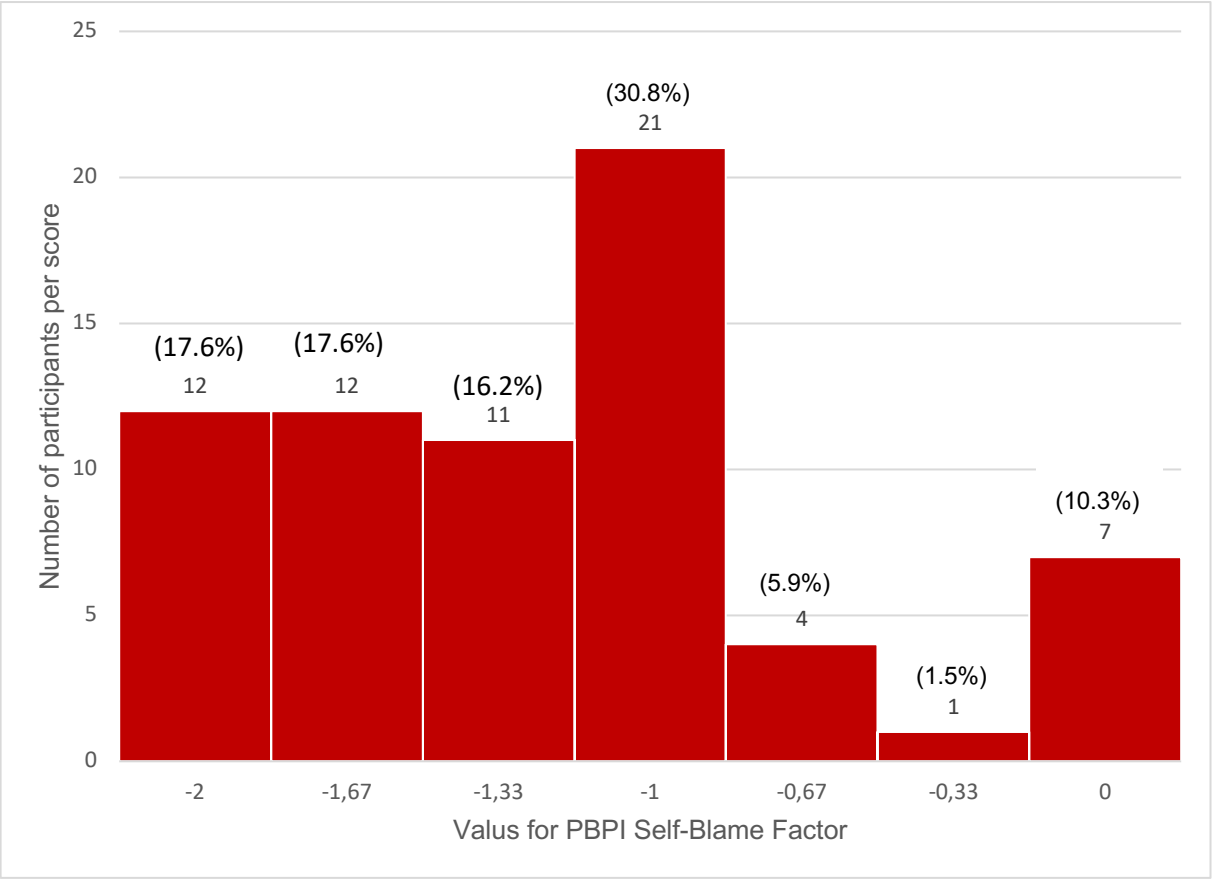


Figure 4. 12 Distribution of the PBPI Self-blame Scores

Values at the bottom of the graph indicate the value of the sub-score, and the data labels the number of participants that scored within that value.

4.6 Objective 4: Determine the differences between males and females in the MSD group for Effort, Reward, Over-commitment, and the FABQ and PBPI scores

4.6.1 Analysis of Differences by Sex in the MSD group

Several statistically-significant differences were found in the effort and reward responses between sexes. It is evident that compared to males, females earned statistically-significantly lower reward scores on both the aggregated reward scale and the reward sub-scales. No sex differences were found in the Over-commitment, PBPI and FABQ scores. (These outcomes are detailed in the Table 4.22 below.)

Table 4. 22 Sex Differences in Effort, Reward, Over-commitment, the Reward Sub-scores, FABQ and PBPI (n=68)

		Sex	Mean ± SD	p value
Effort		Female (n=31)	16.2 ±3.1	0.08
		Male (n=37)	14.9 ±2.9	
Total Reward		Female (n=31)	29.6 ±3.4	**0.01**
		Male (n=37)	32 ±3.9	
Reward Sub-scales	**Reward-Esteem**	Female (n=31)	12.3 ±1.6	**0.03**
		Male (n=37)	13.2 ±1.7	
	Reward-Promotion	Female (n=31)	11.3 ±1.8	**0.05**
		Male (n=37)	12.2 ±1.9	
	Reward-Security	Female (n=31)	6.1 ±0.9	**0.02**
		Male (n=37)	6.6 ±0.9	
Over-commitment		Female (n=31)	15.3 ±3.3	0.32
		Male (n=37)	14.6 ±2.9	
FABQ-W		Female (n=31)	5.9 ±5.3	**0.41**
		Male (n=37)	7.0 ±5.4	
FABQ-PA		Female (n=31)	7.0 ±6.4	**0.31**
		Male (n=37)	8.6 ±6.1	
PBPI Mystery		Female (n=31)	-1.0 ±0.7	0.84
		Male (n=37)	-1.1 ±0.6	
PBPI Permanence		Female (n=31)	-1.1 ±0.8	0.37
		Male (n=37)	-1.3 ±0.6	
PBPI Constancy		Female (n=31)	-1.0 ±0.7	0.80
		Male (n=37)	-1.1 ±0.6	
PBPI Self-Blame		Female (n=31)	-1.2 ±0.7	0.78
		Male (n=37)	-1.2 ±0.5	

FABQ-PA = Fear Avoidance Beliefs Questionnaire- Physical Activity; FABQ-W = Fear Avoidance Beliefs Questionnaire- Work; PBPI = Pain Beliefs Perception Inventory; SD = Standard Deviation

4.7 Objective 5: Determine the Relationship between Effort, Reward, Over-commitment, Ergonomic Risk Factors, the FABQ and the PBPI in the MSD group

The last objective of the study was to determine the relationships between the constructs of effort, reward, over-commitment, ergonomic risk factors, the FABQ and the PBPI in the MSD group.

Reports of the relationships between ROSA, effort, reward, the reward sub-scales and over-commitment in the MSD group appear under Objective 2 of this chapter. No significant relationships were found between effort, reward, over-commitment, the FABQ-W, the FABQ-PA, and the PBPI sub-scores, except for the weak but positive correlation between reward esteem and the PBPI mystery sub-scores ($r = 0.247$, $p = 0.05$). FABQ-PA had a significantly weak negative correlation with PBPI permanence ($r = - 0.314$, $p = 0.01$) and PBPI's self-blame scores ($r = - 0.304$, $p = 0.05$). FABQ-W had significantly weak, negative correlations with PBPI permanence ($r = - 0.370$, $p = 0.01$), PBPI constancy ($r = - 0.319$, $p = 0.01$), and PBPI self-blame ($r = -0.301$, $p = 0.01$). All of the PBPI outcomes were positively correlated with medium to strong relationships, which would by nature be expected. (See Table 4.23 for the values.)

Table 4. 23 Correlation Table of MSD group variables (n=68)

	Effort	Reward	Reward-Esteem	Reward-Promotion	Reward-Security	Over-commitment	ROSA	FABQ-W	FABQ-PA	PBPI Mystery	PBPI Permanence	PBPI Constancy	PBPI Self-Blame
Effort	1												
Reward	-0.271*	1											
Reward-Esteem	-0.228	0.856**	1										
Reward-Promotion	-0.259*	0.874**	0.571**	1									
Reward-Security	-0.162	0.721**	0.503**	0.478**	1								
Over-commitment	0.487**	-0.202	-0.188	-0.108	-0.251*	1							
ROSA	0.136	-0.077	-0.088	-0.123	0.088	-0.018	1						
FABQ-W	0.055	0.106	0.106	0.098	0.038	0.092	-0.072	1					
FABW-PA	0.055	-0.023	-0.144	0.156	-0.141	0.032	0.019	0.211	1				
PBPI Mystery	0.042	0,207	0.247*	0.077	0.229	-0.004	0,023	-0.115	-0.226	1			
PBPI Permanence	-0.082	0,033	0.052	-0.022	0.082	-0.059	0,146	-0.370**	-0.314**	0.503**	1		
PBPI Constancy	-0.098	0,17	0.113	0.19	0.099	-0.057	0,026	-0.319**	-0.151	0.466**	0.583**	1	
PBPI Self-Blame	-0.029	0,1	0	0.138	0.121	-0.094	-0,085	-0.301*	-0.304*	0.312**	0.539**	0.476**	1

*Correlation is significant at the 0.05 level (two-tailed).

** Correlation is significant at the 0.01 level (two-tailed). Values in tables indicate p-values.

4.8 Conclusion as to the Results

Both the MSD group and the reference group consisted of 68 participants each. The main outcome of the results indicates that there was no statistically significant difference between the two groups in any individual, or work-related demographics, except for frequency of exercise sessions. Neither were there any significant differences in the ROSA scores. Work-related psychosocial factors, measured with the Effort-Reward and Over-commitment Questionnaire, found no statistically significant difference between the MSD group and the reference group in terms of the Effort-Reward Ratio. No differences between the sub-scales of esteem, promotion or security were found. However, over-commitment was statistically significantly higher in the MSD group than in the reference group. This MSD group presented with a low level of fear-avoidance beliefs. There were no significantly altered beliefs in any of the sub-scores of the PBPI. There was a significant difference between the female and male reward and reward sub-scales, with females experiencing fewer rewards.

The following chapter sets out to interpret the results of this study in conjunction with the associated literature, discusses the possibility of generalising the findings, as well as the limitations and potential bias of the study.

CHAPTER 5: DISCUSSION

5.1 Outline of the Discussion Chapter

An interpretation of the results follows under the same headings and structure as those of Chapter 4 and in alignment with the objectives of this study. The study's limitations and any potential bias are also discussed, while the possibility of making generalisations about the study results is also explored. The conclusion to the chapter then follows. (The diagram below, Figure 5.1, illustrates the above format.)

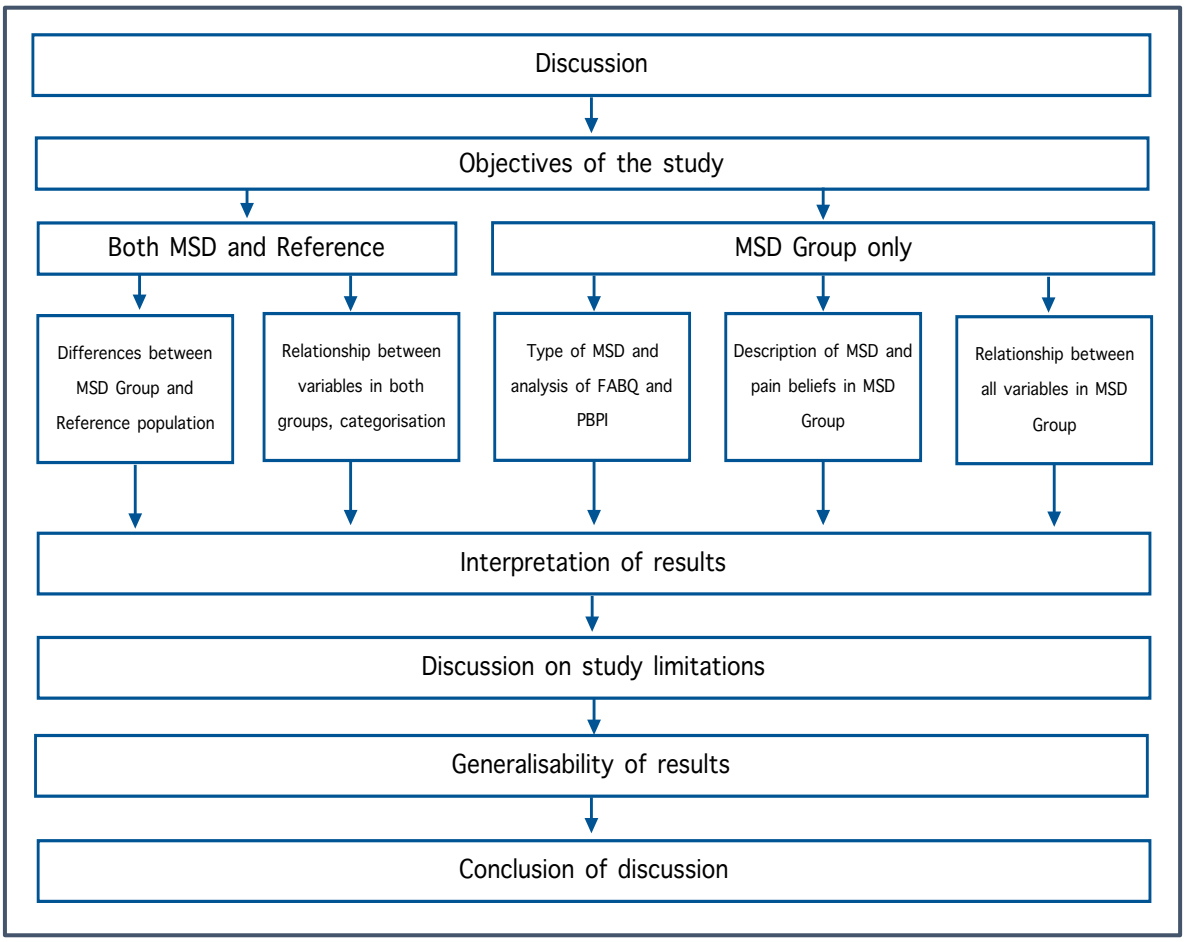


Figure 5. 1 Diagrammatic outline of Chapter 5

5.2 Objective 1: Differences between the MSD group and the reference group

5.2.1 Individual Demographics and Anthropometrics

The sex distribution for the MSD group was fairly balanced at 45.6% for females and 54.4% for males. However, the reference group had a higher percentage of males, 60.3%, than females, 39.7%. This could be due to the fact that females tend to pose an increased risk for MSD (Korhonen *et al.*, 2003; Klussmann *et al.*, 2008; Wu *et al.*,

2012; Collins and O'Sullivan, 2015). A study found that the increased risk for MSD in females is due to the biological differences between the sexes, including muscle mass and distribution, thus affecting their strength, as well as hormonal differences (Bildt and Karlqvist, 2001). Not only do biological differences affect the risk of MSD. Higher work-related psychosocial risk factors, such as work stress and management issues, also contribute to the increased risk that females face in respect of MSD (Widanarko, Legg, Stevenson, Devereux, Eng, Mannetje, Cheng & Pearce, 2012). The roles that they play outside of work, an increased tendency to report MSD, and the work-station set up, based on male anthropometry, have also been suggested as factors that influence the risk for MSD among females (De Zwart, Frings-Dresen and Kilbom, 2001). Females are more at risk for MSD regardless of occupational class, thus indicating that there is no gender segregation in terms of higher-risk occupational classes (De Zwart, Frings-Dresen and Kilbom, 2001). Rather, the above-mentioned factors have a greater influence on MSD.

Owing to the insignificant statistical difference between the ages of the MSD group and the reference group, it seems that age in these population samples is not a risk factor for MSD. This finding is in contrast to studies where age has been considered a risk factor (Wu *et al.*, 2012; Kaliniene *et al.*, 2013; Collins and O'Sullivan, 2015; Celik *et al.*, 2018). Both the MSD group and the reference group presented with a young mean age, in the early thirties, and this could contribute to the insignificant statistical difference in the age variable: - As Kaliniene *et al.,* (2013) noted, there is an increased risk factor of 2.37 for neck MSD between the ages of 40 and 49 years. Collins and O'Sullivan's (2015) mean age was also in the early forties, with males and females presenting with this complaint at the ages of 40.1 years and 40.3 years respectively. The decade mean difference of age between the above-mentioned studies and this one could be the reason for their studies considering age as a risk factor for MSD. However, another study by Wu *et al.,* (2012) showed a similar mean age for men and woman of 31.9 years and 31.1 years respectively as a risk factor for neck MSD. The mean age in the aforementioned study is similar to the mean age of this population sample.

The highest prevalence in MSD in both the 12 month and the seven day periods remained in the neck region therefore it suggests that other factors besides age contribute to MSD in the VDU population sample in this study.

The BMI is a measure derived from height and weight, and refers to an underweight, normal or overweight classification, with normal being between 18.5 and 25.0 kg/m^2. There was no statistical difference for BMI between the two groups. Both groups fall into the overweight class on the basis of the calculations of the mean BMI score, with the MSD group and the reference group BMI values at 26.1 ±5.3 and 26.1 ±4.9 respectively. An increased BMI has been known to be a risk factor for multi-site pain (De Cássia Pereira Fernandes *et al.*, 2016), as well as lumbar pain (Piranveyseh *et al.*, 2016), neck pain (Wu *et al.,* 2012), leg pain in females, and wrist pain in males (Celik *et al.*, 2018). Kaliniene *et al.,* (2013) found increased BMI is not associated with neck MSD. Although the study by Kaliniene *et al.,* (2013) was a small study sample, the BMI does not seem to be a risk factor for MSD, but could add to its compounding effect in that it constitutes part of the multi-factorial nature of MSD.

Right-handedness in both the MSD and the reference group was determined at 91.2% and 95.6% respectively. Right-handedness has been linked to MSD (Oha *et al.*, 2014). However, handedness has been regarded as insignificant by Abaraogu *et al.*, (2018). Both of these studies were conducted on a VDU population. Both the MSD and the reference group in this study were predominantly right-handed, which did not seem to influence MSD in this case, which is in line with the above-mentioned literature. One could speculate that as right-handedness is so prevalent, devices would most likely be set up to be ergonomically sound for right-handed individuals and that such a situation could contribute to the management of associated risks that could lead to MSD. Alternatively, left-handed individuals would have learned to work within a society that is predominantly right-handed and would, therefore, not be influenced by the handedness factor.

Both groups presented with the majority of their participants completing their full-time educational careers between the ages of 19 and 22 years old. The sample population group selected for this study was employed in corporate companies, requiring various levels of skills and or formal training. The nature of the work demands for many of the

participants would require further education for them to fulfil their job requirements. For many of the participants, this would require at least a Bachelor's degree, and would explain why the majority of the participants would have completed their education between the ages of 19 and 22. The members of the second-largest group were between the ages of 23 and 26, which would again imply that they had attained an educational qualification equivalent to a four-year degree, or a post-graduate degree. The third category was in the 16 to 18 year age group, which, in the South African context, includes those still in formal schooling. On the other hand, the category of 27 to 36 years constituted the smallest population. The above-mentioned factors, contributing to formal education could be a reason for both the MSD and the reference groups' sharing of the same distribution of years spent working, since most of the employees in both groups had been working for less than five years or for more than ten.

At this stage, it is worth noting that by questioning the participants as to the level of education that they had achieved, the responses thus received would not indicate at what age the participants would have been eligible to enter the work force. This last consideration is important as this would allow for sufficient time to pass for the compounding effects of sufficient exposure to risk factors that could contribute to MSD to be felt.

The questionnaire also asked about the number of years that the participant had been working. This is discussed at a later stage. Had there been a significant difference between the MSD group and the reference group in terms of the responses to these two questions (age at which full time education had been completed and number of years working), one could have potentially been able to establish other compounding factors related to this information. In order to be in a position to make a comparative study with the minimal data available in terms of the South African population, this question was left to be included in the amendment to the CUPID questionnaire. These comparative figures regarding the educational level of office workers in South Africa were integrated into a section of the CUPID questionnaire (Coggon *et al.*, 2012), where it was found that only 26% of the office workers questioned had an educational qualification that had been attained at an age above 20. This finding differs vastly from this study's results.

Wu *et al.,* (2012) found that participants with higher educational qualifications would show an increased risk for neck MSD. However, Piranveyseh *et al.,* (2016) postulated that a higher level of education results in better job positions and autonomy and that shoulder MSD is less prevalent in such individuals. Kausto, Miranda, Pehkonen, Heliövaara, Viikari-Juntura and Solovieva, (2011) found that participants with lower educational qualifications are inclined to experience increased exposure to physical load. Since the educational levels for the two groups are similar, the increased autonomy and diminished exposure to physical loads could be a preventative factor for MSD in, this particular population sample studied. Furthermore, in the case of this VDU population, it would also seem that the risk factors for MSD do not have a time component linked to them and the age at which the participants complete their formal educational programme does not influence MSD.

A further factor that might contribute to this distribution of years spent working is the mean age of both groups which was 33.3 for the MSD group and 35.3 years for the reference group. Hence, the age when the participants completed their full-time education and their mean age in terms of the distribution of years working accounts for the time spent studying and in entering the work force. As the participants were engaged in fields that might require constant training and mentoring, the age distribution could be in accordance with the organisation's aim for recruiting more experienced staff members to work for more than 10 years in order to mentor the newer staff members, namely those with less than five years' experience. Alternatively, staff members that were working in an organisation for more than five years and that were still not in more senior positions, might have left the organisation, resulting in a smaller group with a working career of six to 10 years. The MSD group and the reference group had 30 participants and 33 participants respectively working for more than ten years.

The risk of MSD in the upper quadrant increases with more than 15 years of using a VDU device, (Ardahan and Simsek, 2016). This study did not support this finding of an increased risk for MSD with increased VDU use. One could argue that the limitation in this respect may have been in the questionnaire. The questionnaire could have been amended to show smaller increments of years spent working in order to establish whether this is in fact a risk factor for MSD. One should also be aware of the influence of age, as discussed previously, and how increased age could increase risk, the

exposure of the worker to VDU use, and the multi-factorial nature of the work-related MSD condition.

Considering the variables of age at which the worker's full-time education was completed, the level of education, and the number of hours spent working, what comes to light is that the individual influences on MSD have been observed in previous literature studies. However, this study did not find any significant differences between these variables in the MSD and the reference group.

No studies appear to have mentioned annual leave in their analyses of MSD in the work place. The distribution of annual leave in this study was regularly spaced over the six months prior to this research. Annual leave may assist with relieving stress, and rest and could be a buffer for the development of MSD. As such, larger study populations would be needed to establish correlations between the respective variables.

5.2.2 Exercise Frequency and Duration

The majority of the MSD group exercised one to three times a week, with the least number sharing the categories of exercising six to seven times a week, and not at all. The rest fell either into the less than once a week or between four and five times a week. The reference group was almost equally divided into the one-to-three times and four-to-five times per week groups, and a very small number of participants exercised for more than six to seven times a week. The reference group exercised almost half as often as the MSD group in the category of 'less than once a week'. The MSD group had four times less participants that were in the "none" category than the reference group. There was a statistical difference ($p=0.02$) in the exercising frequency between the two groups.

The relationship between physical activity and MSD is inconsistent (Korhonen *et al.,* 2013). However, the role of physical activity in preventing neck pain in the VDU user group was shown by Korhonen *et al.,* (2013), and the lack of regular physical exercise increased the odds for MSD by 2.758 (Riccò *et al.*, 2016). Another study found that infrequent physical activity increases the risk for neck MSD by odds of 1.77 (Wu *et al.,* 2012). The compounding influence of high mental stress levels, and a reduction in the

frequency of physical activity increased the risk for MSD by 6.7 (Korhonen *et al.,* 2013). However, the same sample group presented with lower stress levels with an increase in physical activity, and one can speculate that by decreasing stress levels this lessoned the risk for MSD (Korhonen *et al.,* 2013). Although the influence of physical activity as an independent factor might be unknown, its value as a contributing factor needs to be analysed. The length of time spent exercising, as well as the fact that the content of the physical activity session is unknown does indeed make the comments on these findings merely speculative. More than 90% in both groups exercise for an hour or less, and this could be due to time constraints, or the societal norm, but all remains speculation. The role of physical activity in MSD in terms of its interaction with other variables is discussed later on in this chapter, under Objective 2.

5.2.3 Duration of VDU use in the MSD group and the reference group

The large number of hours spent in front of a VDU indicates that the majority of the sample group are employed full time, with only 1,5% and 5,9% respectively in the MSD and the reference groups employed in half-day posts. In both the MSD group and the reference group more than half of the participants work more than the legislated work week, namely a 40-hour week. One could assume that owing to the professional nature of the participants' work, there is no limit to overtime hours as legislation does not prohibit overtime above a certain salary bracket or in employees in senior management (*The South African Department of Labour*, 2018). Employees would need to complete the job requirements and may either be compensated for extra hours or be expected to work the extra hours in order to complete the tasks as per the job requirements. The fact that the participants indicated overtime in a normal work week could mean that the effort section of the questionnaire would be influenced by this.

Two of the six questions in the effort portion of the Effort-Reward Imbalance Questionnaire pertain to time. 'I experience constant time pressure due to heavy work load', and 'I am often pressurised to work overtime'. This could perhaps influence the effort component, where two of the six questions refer to time factors. In the light of this, and in spite of recordings of extra effort, the Effort-Reward Ratio remains below one, and in this sample population, the reward construct as a whole clearly outweighs the time/hours component.

Participants were also asked: ‘How many hours a day do you work in front of a visual display unit/screen?’. This open question allowed the participants to indicate the number of hours of VDU use they engaged in in order to complete work-related tasks, irrespective of site/location and whether they used the computer at work or at home. Since their occupations require their use of a VDU to fulfil their job requirements, the amount of time spent at work would by nature influence the amount of time spent at the VDU. As some job descriptions may not require the use of a VDU, the deficit in a normal working day of VDU work could be attributed to work responsibilities or legislative breaks requiring time away from the VDU. The majority of both groups worked between six and eight hours a day with a VDU, while 25 % of the reference group and 26,5 % of the MSD group worked for more than eight hours a day. As stated by Wærsted *et al.*, (2010) and in terms of inclusion criteria alone, by working with a VDU for more than four hours a day, both the groups would be at risk of MSD. However, this study, also conducted in a developing country, shows no difference between the two groups in terms of VDU time, and supports earlier notions that VDU use alone is not associated with MSD (Kaliniene *et al.*, 2013).

The objectives of the study did not question the participants about their individual preferences regarding the breaks taken within the working cycle. A lack of breaks increases the risk of MSD (Kaliniene *et al.*, 2013; Ardahan and Simsek, 2016; Celik *et al.*, 2018), and as the variable, namely, breaks taken, was not included in the questionnaire, one could only speculate regarding the influence of this variable. There are more variables that are not within the scope of this study when one looks at duration at a VDU and MSD.

5.2.4 VDU set up in the MSD and the reference group

The dynamic nature of sitting does not always reflect the ergonomic guidelines (Woo, White and Lai, 2016) and hence the work requirements. While collecting the data, it became obvious that the variety of work station set ups could be as a result of the work requirements or the devices issued by the employers or even the preference of the end user in terms of comfort.

The preference for comfort over neutral postures was supported in the study by Asundi *et al.*, (2012), and was a consideration when implementing ergonomic guidelines (Woo,

White and Lai, 2016). Sixty participants in the MSD group and 51 participants in the reference group used laptop devices or combinations of various devices. The risks for an increase in MSD are compounded by the use of laptops on account of the increased muscular load, more non-neutral postures as opposed to postures associated with desktop use (Asundi *et al.*, 2012; Saied, Kamel and Mahfouz, 2013; Werth and Babski-Reeves, 2014), increased neck flexion angles and the limited adjustability of the work station (Werth and Babski-Reeves, 2014). The recommendation to limit the time period (duration) spent working on a laptop in order to minimise the impact of these risks (Saied, Kamel and Mahfouz, 2013) is clearly not an option in this population group when account is taken of the number of hours worked per week, and the number of hours in a day using a VDU.

Although the above-mentioned risk factors should increase the risk for MSD, this did not occur in this study population, as the VDU set ups for the two groups were not statistically different and could not therefore, be considered to contribute to the multi-factorial risk factors prevailing in this MSD group. Thus, the suggestion to rather conform to desktop work-station set ups, or ergonomic supportive equipment, in order to improve the laptop set-up, could be made in order to minimise the risk associated with laptops and non-neutral postures, and aim manage the confounding risk of this multifactorial problem.

5.2.5 Effort-Reward Imbalance and Over-commitment

The Effort-Reward Ratio in the MSD and the reference group, was calculated as less than one, and indicates that the reward is greater than the effort. This is a positive as it minimises the risk for reduced health, stress and burnout (Van Vegchel *et al.*, 2005; Koch *et al.*, 2014). A score of more than one, where the efforts are greater than the rewards, poses a risk in that the individual might experience negative emotions and a sustained stress response (Siegrist 2012).

The systematic review by Koch *et al.,* (2014) indicates that there is only moderate evidence to the effect that the effort-reward imbalance reflects an association between the psychosocial factors as tested by the model and MSD. This review includes a variety of population groups, with only three studies being potential users of a VDU. This current study contradicts those findings as neither of the sample groups presented

with any imbalances or significant differences. The effort section included two questions relating to work and time. Taking into account the hours of work per week and per day spent in front of a VDU, as discussed above, both groups would be likely to have high scores in a third of the effort section. The Effort-Reward Imbalance Model is said to impact upon the global trends on the labour market, with suggestions that the sub-scores of reward reflect economic trends (Koch *et al.*, 2014). The reward sub-scores were also found to be insignificantly different, and this may be due to the reward component being affected by the nature of the economy. One could speculate that all participants may be equally affected by a lack of promotional prospects. However, job security in both groups is in the higher quartile. Further speculation would suggest that the reward sub-score, esteem, can be improved and corrected since this variable is not related to economic influences; it is a feeling of respect and a perception of how one is treated at work. Interventions to assess and address rewards could be implemented and further studies should be conducted.

Over-commitment, an intrinsic factor, is said to refer to individuals, who have an excessive work-related commitment, as well as a need for approval. They are also more at risk of a perceived higher efforts, and lower rewards, hence a poor Effort-Reward Ratio, or non-reciprocity (Siegrist *et al.*, 2004). However, non-reciprocity was not seen in this study population, and so is not a risk factor in this population. Koch *et al.,* (2014) found inconclusive evidence that over-commitment results in more frequent MSD than in non over-commited VDU users. On the other hand, this study adds to the body of knowledge with over-commitment being perceived as significantly different for the MSD group and the reference group. The over-commitment questions allow a score range of between six and 25 points: the higher the score, the higher the level of over-commitment. The MSD group had a score of 14.9 ±3.1 and the reference group one of 13.8 ±3.4, ($p = 0.04$).

The over-commitment questions test the ability/inability to withdraw from work and the inclination to provide for an over-the-top effort (Siegrist *et al.*, 2004), and are person-specific (Van Vegchel *et al.*, 2005). Over-commitment is elevated in those who have a misconception of the demands of the job, as well as in those with poor coping strategies (Siegrist, 2012), and a distorted perception of their own cost-gains relations (Siegrist, 1996). Over-commitment has been associated with poor self-rated health

(Siegrist *et al.,* 2004), and intensified stress symptoms (Feldt *et al.,* 2013). The MSD group could be at risk of inflating their own MSD problems through inaccurate recall, and work demands, even though these aspects may be similar for the reference group.

The individual is considered even more at risk for diminished health with high over-commitment and non-reciprocity levels (Siegrist *et al.,* 2004) the MSD group potentially falls into this category. Over-commitment is also said to ~~be~~ contribute to emotional exhaustion over time (Van Vegchel *et al.,* 2005). These findings do in fact indicate the need to address these risks in order to maintain an optimal level of occupational health and to minimise disability. Addressing non-reciprocity and over-commitment through psychological detachment, relaxation, mastery and control, has been found to be important in the management of the potential risk for burnout and poor recovery (Feldt *et al.,* 2013).

In a study by Feldt *et al.,* (2013) over-commitment was found to be a motivational factor for work engagement. However, this is not to be recommended as a course to follow. Over-commitment proved to be significantly higher in men in a sick-listed group with neck and back pain (Myhre *et al.,* 2013), and further research is needed to establish relevance and interventions to address this issue in order to prevent disability, as well as to contribute to the healing and welfare of a sick-listed population. This was not the objective of this study, but does show that there is a relationship between over-commitment and MSD which warrants further investigation.

5.2.6 Rapid Office Strain Assessment Results

There was no significant difference between the MSD group's and the reference group's risk assessment scores. These findings support others' research that also found no association between the work-station set up and MSD (Klussmann *et al.*, 2008; Wu *et al.*, 2012; Coelho *et al.*, 2015; Lima and Coelho, 2018). The work station has many components, and the lack of association between poor ergonomics and MSD may be due to the various assessment methods, and components tested. As discussed in the literature review, the tools used influence the risk factors within the assessment.

One of the key components of a poor work station that has been linked to MSD, namely a lack of forearm support (Leyshon *et al.*, 2010; Wærsted, Hanvold and Veiersted, 2010). However it has not been assessed in the above-mentioned studies. The ROSA has a few drawbacks which could have contributed to the lack of differentiation between the two groups assessed in this study, and will be elaborated upon below.

The mean value for both groups was a classification of four, thus pointing to a medium-risk classification, where scores of five or more require immediate change (Sonne *et al.,* 2012). A score of less than five does not mean that there is no room for improvement. It is still a risk factor and requires adjustments to the optimum. As only 14 and 16 participants in the MSD group and the reference group respectively, had scores of three, the remaining participants all had areas to address to minimise risk. Addressing these components to improve comfort is supported by Leyshon *et al.,* (2010) and was conducted in this study.

The ROSA poses some challenges as one high sub-score can cause a high final score, even though the rest of the work station is not at risk to the same extent. A score of five or more on Arm and Back Support sub-score would by default result in at least a five final ROSA score. The seat pan height/depth sub-score, a score of six or more on this assessment, would by default result in at least a five final ROSA score. Not one of the participants had an adjustable seat pan, and hence all would score at least one point in this section.

The monitor score reflects risk factors pertaining to position, height, distance, non-neutral postures, glare, document holders and duration. All participants were awarded a point for the duration of the work period, as, by inclusion, all participants used the VDU for more than four hours a day. The lowest a participant could score was a value of two - for the correct distance and level at which the monitor was mounted. The distribution of scores is aligned with the use of multiple monitors, a poor desktop set-up, and the laptop components, to which the participants assessed had access. Most of the participants' scores increased on account of their unsatisfactory distances from the VDU, the height of the monitor, and their neck twist scores.

Both groups had a majority of participants that used a telephone for less than 30 minutes a day and were awarded a negative point, resulting in scores of one and two on this subscale. The scores for monitor and telephone were low because of the low telephone scores. As this section contributes to the final ROSA, a very low telephone score could reduce the final ROSA score. However, a participant could experience a neck twist, a lengthy duration of time, and the screen at a high level, thus scoring three. The low telephone score of one or two would result in a section score of two. This is a low-risk score. However, considering all of the literature that non-neutral and awkward postures are known risk factors for MSD (Devereux, Vlachonikolis and Buckle, 2002; Wahlstedt *et al.*, 2010), and should be addressed, such a low score is misleading in a risk assessment. In a large-scale intervention, an employee, who presents with what ROSA may consider a small risk factor, could in fact be at high risk owing to other physical and psychosocial factors contributing to the MSD multi-factorial risk. As such, by not effectively minimising a small physical risk factor, one would not be effectively managing an MSD risk.

A minimum score of two points would be possible in the keyboard category. One point for neutral wrists, and since all participants would also be awarded a point for more than four hours a day in front of a VDU, the second point would be awarded by this time factor. Scores increased with participants in wrist extension, wrist deviation, and with shrugged shoulders. Elevated shoulders would be penalised at this stage, as well as in the back support section. Owing to the nature of the participants' job requirements, none of the participants received a score for reaching up to overhead items.

The use of laptops generally influences this score on account of the added wrist extension, deviation and elevated shoulder in order to compensate for neck flexion. The same argument as for the Monitor and Telephone Score applies to this section too and even a low physical risk factor should be addressed as a compounding effect emanating from multiple risk factors that affect MSD.

All participants used a pincer grip with the mouse. Duration scores varied, as not all participants required the mouse for the job tasks. Reach and palm rest also influenced these scores. The monitor and peripherals scores were derived from the keyboard and

mouse score, as well as from the monitor and the telephone scores Any score of five or more in this section would immediately result in a final ROSA of five or more. The monitor and telephone scores were all under four for both groups. However, the effects of the keyboard score resulted in a higher score at this point.

Even though the risk assessment programme does not indicate a high risk for MSD, it does not exclude the fact that participants may still experience risk factors that are not observed in the ergonomic risk assessment. These could include non-neutral postures (Wahlstrom, 2005; Das and Ghosh, 2010; Ranasinghe *et al.*, 2011; Bruno Garza and Young, 2015; Sun, Nimbarte and Motabar, 2017; Celik *et al.*, 2018), sustained neck flexion (Wu *et al.*, 2012; Sun, Nimbarte and Motabar, 2017) and sitting for the majority of the day (Lis *et al.*, 2007). There is moderate evidence to the effect that forearm support is able to independently improve upper quadrant comfort and reduce pain in the neck, shoulder and upper quadrant (Leyshon *et al.*, 2010; Wærsted, Hanvold and Veiersted, 2010). The ROSA does not measure of the above-mentioned risk factors. However, the results of this study add to the body of knowledge that work-station set up alone is not related to MSD (Klussmann *et al.*, 2008; Wu *et al.*, 2012; Coelho *et al.*, 2015; Lima and Coelho, 2018). However, since the belief that MSD is caused by the work-station set up, which is a risk factor for MSD (Oha *et al.*, 2014), clinicians should use all clinical judgement when issuing ergonomic interventions in order to avoid a heightened risk for MSD.

5.3 Objective 2: Determine the relationships between Effort, Reward, Over-commitment and Ergonomic Risk Factors in VDU users in the MSD group and the reference group

No statistically significant relationships were found between the ROSA scores (ergonomic set up) and the effort and reward measures in both the MSD group and the reference group. In the MSD group, effort was significant negatively correlated with reward and the sub-score, reward promotion. The reference group presented with a weak negative correlation between effort and reward, and between effort and reward security, and a weak negative correlation between effort and reward promotion. It is expected that, by nature, the Effort-Reward Imbalance Model would have some significant correlations between the respective variables. This can be explained by the fact that the Effort-Reward Imbalance Model is based on the notion of reciprocity

between effort and reward, where effort forms part of the worker's contract to work, and the reward sub-scales are the reciprocals of the effort expended. The two are on opposite ends of the spectrum, and a negative correlation would be expected (Siegrist, 1996). However, this was found to be a weak correlation, and although these findings differ from those of van Vegchel and de Jonge, (2005), who found a moderate, negative correlation between effort and reward, the authors noted that there are few studies that test the interaction between the individual constructs. By nature, the reward sub-scales and the total reward score would be strongly and positively associated.

The MSD group had a weak positive correlation between effort and over-commitment, whereas the reference group had a moderate positive correlation between effort and over-commitment. The correlation between effort and over-commitment could be due to the fact that over-commitment contributes to the motivational pattern for excessive work-related commitment, as described by Siegrist *et al.,* (2012) and potentially results from exaggerated efforts (Van Vegchel *et al.,* 2005). Over-committed employees tend to underestimate the challenges presented to them, inflate their own skills, as well as invest too much in their efforts (Van Vegchel *et al.,* 2005). The reference group could present with a stronger relationship between effort and over-commitment without signs of MSD since, the perception of reward is sufficient to counteract the effects of effort.

The influence of over-commitment was discussed previously, and is also dealt with in the next few paragraphs, where the study by Feldt *et al.,* (2013) focuses on recovery from over-commitment. The use of these recovery methods could explain why the reference group has a higher correlation with Effort, yet is not classified in the MSD group. Feldt *et al.,* (2013) discusses the influence of recovery experiences over time to manage burnout from non-reciprocity and high levels of over-commitment. This study assesses various ways to recovery, and indicates that psychological detachment, relaxation, mastery and control during off-job time promote well-being. Although this issue did not constitute an objective of this study, and is in fact beyond its scope, it is possible that physical activity in the members of this MSD group was adding to their exhaustion as opposed to aiding their recovery.

Over-commitment in the MSD group showed a weak negative association with reward security. The reference group had a weak negative correlation between over-

commitment and reward esteem, as well as reward security, and a weak negative correlation with reward promotion. As an over-committed individual has a strong desire for control, approval and distorted perceptions, this prevents him/her from objectively assessing their own cost-gain relations (Siegrist, 1996), and based on inadequate feelings of approval, could indicate misplaced perceptions of job reward, and the reward sub-scales. Although in this study non-reciprocity was not linked to MSD, the MSD group could be at risk of other health risks related to non-reciprocity.

From the model generated to establish categorisation into the MSD group or the reference group, increased levels of over-commitment are associated with classification into the MSD group. Additionally, individuals who do not exercise at all are 4.49 times more likely to be in the reference group, while those who exercise four to five times per week are 2.47 times more likely to be in the reference group. This means that those in the reference group might be exercising optimally at a frequency of four to five times a week, and this could be preventative of MSD or act as a buffer for risk factors. This is in line with the research, where the use of exercise for the management of MSD is well supported (Nijs *et al.*, 2015; Booth *et al.*, 2017; Smith *et al.*, 2018).

The frequency of exercise for the management of neck MSD in the work place, for instance, was found to be more effective when carried out more than three times per week (Tunwattanapong, Kongkasuwan and Kuptniratsaikul, 2015). Whereas, the members of the MSD group were perhaps under-exercising, since the majority were in the one to three times a week group, this might be insufficient as a preventative measure or buffer against MSD.

Interestingly, the highest odds ratio was still in the individual that did not exercise at all. By using this model, the correct frequency of exercise might be important for further research within this sample group. The MSD group had fewer participants who were not physically active at all, and almost half as many as the reference group that were exercising four to five times a week. There was a significant difference between the frequency subgroups in the MSD group and the reference group ($p=0.02$), where the majority of the MSD group exercised once to three times a week, and the reference group had more participants who did not exercise at all. The fact that the reference

group had more participants not exercising at all contradicts the research regarding the role of exercise in the management of MSD, and the model fit. However, this highlights the multi-factorial nature of MSD, and although this is beyond the scope of this study, further research into this sub-group of the reference group may be warranted in order to understand this anomaly. The influence of physical activity on MSD was discussed under Objective 1, and various studies have highlighted the conflicting evidence (Korhonen *et al.*, 2003; Wu *et al.*, 2012; Riccò *et al.*, 2016). The influence of over-commitment was also discussed, and worthy of note perhaps, is that physical activity is just another component where the individual in the MSD group could obsessively commit to exercise.

Alternatively, as seen in the model above, exercising at a frequency of four to five times per week is a preventative measure for MSD. Riccò *et al.*, (2016) suggest that regular physical activity is needed since a lack of regular physical activity in their study increased the odds ratio for MSD by 2.758. As in this study, regular activity of four to five times a week was found to reduce the odds ratio for MSD by 2.47. These findings, as well as those of Riccò *et al.*, (2016), may indicate that physical activity could be preventative of MSD. Korhonen *et al.,* (2003) also states that the influence of mental stress and a lack of physical activity increase the odds for MSD. As over-commitment is statistically significant, the compounding factors of stress may play a greater role as influencing factors than was initially anticipated.

The Effort-Reward Ratio and the ROSA are not predictors of categorisation into the MSD group. As discussed in Objective 1, this could be due to insignificant differences between the two groups.

5.4 Objective 3: Describe the type of MSD and the associated pain beliefs in VDU users in the MSD group.

5.4.1 Nordic Musculoskeletal Questionnaire Results

The 12-month prevalence rates in this study mirror other studies with the highest scores in the neck (69.1%), shoulders (57.4%), lower back (41.2%), and upper back (39.1%), followed by the hands/wrists (25%), knees (19.1%), elbows (5.9%) and ankles/feet (5.9%) (Huisstede *et al.*, 2006; Klussmann *et al.*, 2008; Mirzaei *et al.*, 2014;

Oha *et al.*, 2014; Maakip, Keegel and Oakman, 2016). The seven-day prevalence rates were found to be slightly higher across all regions, but share the same top four groupings, namely neck (33.9%), shoulders (27.9%), lower back (13.2%), and upper back (16.2%). The difference between the 12-month prevalence and seven day prevalence could be due to recall. The shared top-four grouping does give an indication of the risk areas for MSD in the VDU user.

Although the prevalence rates are high, the fact that 49 of the 68 participants felt that the MSD did not affect function may be an indication of the level of intensity of their experience of MSD. This also indicates that for these 49 participants the MSD does not influence activity and is, therefore, not disabling. The number of participants indicating a loss of function on account of MSD is higher in the categories that have higher rates of prevalence, such as the neck, shoulder, and upper and lower back.

Fifty (50) of the 68 participants indicated that the MSD did not call for quests to seek medical attention. This could be an indication that the intensity of the MSD experienced by those individuals was not sufficient to warrant seeking help. One could note that the categories that have higher rates of prevalence, such as the neck, shoulder and upper back respectively, could warrant a search for medical attention. One could speculate that these areas are not only more frequently affected, but also more severely affected, thus resulting in individuals seeking medical attention.

The CUPID study indicates that in the South African population the individual is financially responsible for the full fee when consulting a primary care doctor (Coggon *et al.*, 2012). A reason for the majority of the participants not seeking medical attention may be due to the economic financial constraints that full-fee payment places on them.

Multi-site pain is common in VDU users (Oha *et al.*, 2014; Neupane and Nygård, 2017). This study supports these findings as many of those suffering from MSDs indicate that they experience multi-site pain, with 77.9% (n=53) experiencing more than one site of pain. It is a matter for concern that as many as seven participants were found to present with more than five sites of pain, with the majority of participants experiencing two sites.

Although the Nordic Musculoskeletal Questionnaire does not establish chronicity, multi-site pain is common in chronic pain individuals (Marchand *et al.,* 2015). This could explain the tendency, but would merely be speculation. Alternatively, multi-site pain is said to be a continuum of single-site pain that is sustained by exposure to several risk factors (De Cássia Pereira Fernandes *et al.*, 2016).

5.4.2 MSD group Pain Beliefs as established by means of the FABQ and PBPI

In order to understand pain development, it is important to understand the significant factors that contribute to pain perception, such as beliefs, experiences and actions (Damsgård *et al.*, 2011). The fear-avoidance model suggests that chronic pain syndromes develop once normal expected recovery is halted when the individual is presented with pain as threatening, he/she manifests with catastrophising tendencies, as well as the fear of pain, and anxiety (George and Stryker, 2011). The prevention of chronicity should include methods to address inappropriate fear-avoidance beliefs in the acute stage (Waddell *et al.*, 1993). Acute pain beliefs are an appropriate adaptive method. However, if these beliefs are maintained in the chronic pain situation, they are considered maladaptive (Turk and Okifuji, 2002). Hence pain beliefs develop with chronicity.

The mean values for the two subsections of the FABQ were 6.5 ±5.4 (FABQ-PA) and 7.9 ±6.3 (FABQ-W). These values indicate that the MSD group does not present with any fear-avoidance beliefs. This conclusion is drawn as the values are below the cut-off scores, as indicated by Cleland, Fritz and Brennan, (2008) which are 29/42 for FABQ-W and 13/24 for FABQ-PA. Scores above these values are said to be indicative of poor outcomes with traditional therapy and may warrant a change in treatment to alternatives such as cognitive behavioural therapy (Cleland, Fritz and Brennan, 2008).

Two reasons could explain these results. The first reason could be that the sample population does not experience chronic pain, since, as described above, the beliefs have not become maladaptive. Instead, the members of this group suffer from incidents of acute pain. The Nordic Musculoskeletal Questionnaire does not establish chronicity. Instead, it requests participants to recall MSD over the previous 12 months prior to their completion of the questionnaire. As chronicity has not yet been established, the unknown status of the MSD has a ripple effect since the FABQ

presents conflicting evidence in terms of the acute pain population (Waddell *et al.*, 1993; Williamson, 2006; Cleland, Fritz and Brennan, 2008). It does, however, seem unlikely that the entire population has had or is currently experiencing episodes of acute pain, considering that the prevalence of chronic pain is as high as in one in five individuals (Monti and Caporali, 2015). Although this is only speculative, it may mean that even the chronic pain patients in the MSD group do not have altered pain beliefs that contribute to their pain experience. Alternatively, the pain beliefs could have been treated in therapy.

Secondly, the validity of the FABQ as a predictor of the outcomes, pain and disability, has been questioned in the private insurance population (Cleland, Fritz and Brennan, 2008), whereas the FABQ-W is predictive of pain and disability in the Workman's Compensation patient (Cleland, Fritz and Brennan, 2008). Owing to the findings in the Cleland, Fritz and Brennan, (2008) study regarding private insurance population, even the 16 participants in this study who presented with elevated scores in the FABQ-PA, should be interpreted with caution as experiencing fear-avoidance beliefs. With due consideration of the fear-avoidance model, as it was originally designed, as well as the afore-mentioned factors, one can safely deduce that this VDU-user population does not present with fear-avoidance pain beliefs. The review by Lee *et al.,* (2015) highlights the fact that the pathway of pain to disability, as described by the fear-avoidance model, lacks empirical evidence. Considering the above findings by Cleland, Fritz and Brennan, (2008), and the recent review by Lee *et al.*, (2015), it does make one wonder what the FABQ really measures.

The negative mean scores of all the PBPI sub-scores, namely mystery, permanence, constancy and self-blame, indicate that the participants did not endorse these pain beliefs. According to these values, one could draw the conclusion that the VDU population does not present with altered pain beliefs. As in the FABQ, one reason why this population group has no altered pain beliefs could be due to the lack of chronicity within the group, or the limited time that has passed to establish altered beliefs.

The mystery belief endorses the belief that pain is a mysterious, aversive and misunderstood phenomenon, and could be indicative of a perpetual pain state. This may be different from the cultural norm of pain as a warning system. Self-blame is the

belief that the individual is to blame for his/her own pain experience (Williams and Thorn, 1989). PBPI mystery, as well PBPI self-blame, had no participants in the positive camp. Hence, the entire MSD group does not endorse these beliefs. Alternatively, those who have chronic pain and could develop altered pain beliefs, are self-efficacious and have positive self-perceptions. Hence, they do not have pain beliefs of the mystery factor, as described by Williams and Thorn (1989). PBPI mystery and PBPI self-blame are not related to pain intensity (Williams and Thorn, 1989). This would clarify the results of the Nordic Musculoskeletal Questionnaire in which the MSD group indicated no history of seeking medical attention.

Permanence beliefs imply that pain is an enduring part of life (Williams, Robinson and Geisser, 1994). The PBPI permanence had only five VDU users with positive scores, the highest being 1.25. By definition, this could be a positive adaptation since it could point to acceptance of the pain state. In the study of whiplash patients, the permanence sub-scale was associated with greater pain intensity and predictive of disability (Bostick *et al.*, 2015). As this population did not endorse the belief, one could extrapolate the findings to state that the risk of disability from pain is low, and hence this can be considered to be a positive adaptation.

The PBPI constancy was not endorsed by the MSD group, and hence implies the belief that by nature, pain is intermittent and not constant (Williams, Robinson and Geisser, 1994). Only two of the VDU users in this group had scores above zero, to a maximum of 0.5. All others did not, therefore, believe that pain, by nature, is constant. This could assist participants in strengthening their resolve to continue to function and maintain all roles, despite incidents of pain, owing to the belief that, by nature, pain is intermittent. As the participants also showed no belief in mystery, and may have developed skills in self-efficacy, their belief in the intermittent nature of pain would allow them to maintain function.

5.5 Objective 4: Determine the differences between males and females in the MSD group in respect of Effort, Reward, Over-commitment, and the FABQ and PBPI scores

No significant differences were evident in the pain beliefs between males and females. Although there was a lack of endorsement of the pain beliefs in the MSD group, further

discussion is warranted. The FABQ-W is generally more sensitive to disability and absenteeism in males than in females (Waddell *et al.,* 1993). However, in this study, both the FABQ-W and FABQ-PA were not endorsed; nor did they show any statistically significant difference between the scores for males and females. As previously discussed, both the sexes would have the same exposure to risks, and as the FABQ-W scores have been known to be lower - owing to the lower physical demands made on VDU and white-collar workers, one would not expect different results in terms of this variable for the different sexes. As discussed in Objective 3, the similarity of the respective PBPI sub-scores could be as a result of a lack of chronicity in the MSD group, in which pain beliefs could in fact develop.

Differences between sexes in terms of risk factors, physical and psychological, for work-related MSD have previously been mentioned. Mention has also been made of how the different sexes react to the risk factors, resulting in variations in the MSD condition (Lima and Coelho, 2018). The Effort-Reward Imbalance Model has been found to be specific to sex (Lapointe *et al.*, 2013). However, in this study the effort and over-commitment scores were not found to be significantly different in terms of sex. Several statistically significant differences were found in the reward responses between the sexes. This is not surprising considering that the Effort-Reward Imbalance Model has generally shown differences between sexes (Lapointe *et al.*, 2013). In this study, as opposed to males, females presented with significantly lower reward scores on both the aggregated reward scale, as well as the reward sub-scales of esteem, security and promotion. As in this study, in a study of VDU administrative staff (Lima and Coelho, 2018), job security was also rated lower among females than among males. Woman were more at risk for poor health outcomes when concurrently exposed to both postural risk factors and psychosocial factors (Lapointe *et al.*, 2013). Although the Effort-Reward Imbalance Model does not address work-life imbalances, one could extrapolate the findings by Maakip, Keegel and Oakman, (2017) that indicate that there is a stronger correlation between a poor work-life balance and MSD in women in a developing country. The added roles that woman need to accept and manage may add to feelings of inadequate rewards in the work place, or, on account of home commitments, perceptions of limited opportunities for promotion and job security. On account of the multi-factorial nature of MSD, and the influence of sex, high-risk

populations, such as female workers, should become a priority in further research and intervention studies.

In a study of neck and back patients, males presented with significantly greater effort and higher levels of over-commitment than females (Myhre *et al.*, 2013). These results differ from those for the reference group in the study by Myhre *et al.,* (2013), as well as from the results of this study. Although this study did not find any differences in ergonomic risk factors, which, to an extent address non-neutral postures, the effect of over-commitment, poor reward scores, as well as a medium-risk ROSA, could be compounding factors that contribute to increased risk among female VDU users.

5.6 Objective 5: Determine the relationships between Effort, Reward, Over-commitment, Ergonomic Risk Factors, and the FABQ and PBPI in the MSD group

No significant relationships were found in this study between effort, reward, over-commitment, and the FABQ-W, FABQ-PA, and PBPI sub-scores, except for the significantly weak positive correlation between reward esteem and the PBPI mystery sub-score ($r = 0.247$, $p = 0.05$). FABQ-PA had significantly weak negative correlations with PBPI permanence ($r = 0.314$, $p = 0.01$) and the PBPI self-blame scores ($r = 0.304$, $p = 0.05$). FABQ-W had significantly weak negative correlations with PBPI permanence ($r = 0.370$, $p = 0.01$), PBPI constancy ($r = 0.319$, $p = 0.01$), and PBPI self-blame ($r = 0.301$, $p = 0.01$). All PBPI outcomes were positively correlated, with medium to strong associations, which, by nature, were to be expected. (See Table 4.23 for the values.)

The FABQ-PA and FABQ-W presented with a significantly weak negative correlation with PBPI self-blame. The belief that physical activity causes pain or that work causes pain was negatively associated with the belief that the self is to be blamed for the pain. These variables would, by definition, be negatively correlated, as the two beliefs are contradictory. Considering the comments of Cleland, Fritz and Brennan, (2008) and Lee *et al.,* (2015) concerning the validity of the FABQ, and whether it does in fact measure poor outcomes, the findings concerning the PBPI self-blame variable could mean that it should be considered to be a measure of belief rather than a measure of outcome.

The FABQ-PA and FABQ-W showed weak negative correlations to PBPI permanence. The permanence belief means that pain is an enduring part of life (Williams *et al.,* 1994). Hence, these findings suggest that the belief that physical activity causes pain or that work causes pain is negatively associated with the belief that pain constitutes part of one's life. This is a logical correlation, albeit weak. If the belief of permanence is to be accepted, then the fear of physical activity causing pain should not be accepted. Otherwise, there could be a contradiction of beliefs.

A weak negative correlation was found between FABQ-W and PBPI constancy, which could mean that should the fear-avoidance belief that work causes pain be endorsed, the negative correlation with the PBPI constancy belief would imply that pain is then considered to be intermittent. One could speculate that the FABQ-W measures the fear that pain is caused by work, and is an indication of pain and disability, and chronicity. The negative relationship with PBPI constancy would make sense as the belief that pain is intermittent is not indicative of chronicity.

Reward esteem showed a weak, positive correlation with PBPI mystery. Although this was statistically significant, to the author's knowledge, this does not make much sense, nor does it offer much insight, and hence would consider it irrelevant. All PBPI sub-scores were positively correlated, with medium to strong associations, which, by nature would be expected, as all the sub-scores constitute part of the PBPI.

Research by Myhre *et al*., (2013) concluded that the FABQ-W was associated with over-commitment, however these results were not evident in this study. This could be attributed to the fact that the sample population in the above-mentioned study (Myhre *et al.,* 2013) focused on patients who were sick-listed, and on the fact that the sample group presented with a higher level of fear-avoidance beliefs about work than was the case in this VDU-user sample population.

5.7 Limitations of the Study

A sample of convenience was used in Gauteng. This might not be a true representation of all VDU users in South Africa. Data collection did not take place on the same day or at the same venue, even though it was undertaken in the logistically-shortest possible period of time. This could have introduced an element of bias, even if measures were

in place to minimise the influence of outside factors. The variety of professions and occupations within the various companies employing the members of the two sample groups in this study did limit the ability to generalise on all of the findings. On account of its specificity, as well as the efforts of the participants to improve the work station as the assessment was being conducted, the ergonomic risk assessment may have limited reach. Furthermore, the outcome measures of the FABQ and PBPI might not have been the optimal choice to use in this population on account of the need for chronicity in terms of MSD in order to influence pain beliefs. Another alternative might have included a risk assessment tool for poor outcomes such as the Keele STarT MSK Tool, that addresses multiple sites/locations of MSD.

5.8 The Possibility of generalising the Results

Even though the limitations of the study have been mentioned, this is the only known study done within the South African context and within a group of VDU users. Like other international studies, this study found no correlation between the work-station set up and MSD. South African physiotherapists should then be cautious in educating patients using VDUs in terms of their ergonomic work station conditions without assessing all other relevant factors.

As this sample population did not show altered pain beliefs, physiotherapists should assess the pain beliefs of all VDU users to establish such beliefs before implementing interventions that may not be indicated. Since over-commitment is an intrinsic factor in the individual, the significance of over-commitment as a risk factor for MSD - as seen in this VDU population - does indicate that there is a need to assess over-commitment in all individuals, regardless of occupation.

5.9 Conclusions of this Discussion

The multi-factorial nature of MSD in the VDU user is a useful concept in the interpretation of the findings of this study, and the results of this study should be seen as being integrated with the existing literature. The influence of intrinsic factors, such as over-commitment, is highlighted in this study, as well as in other studies. The awareness that none of the participants in this research study presented with altered fear-avoidance beliefs or pain perceptions, as well as the fact that these variables do

not appear to influence MSD through correlations with other variables, should act as a guideline for future research.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS FOR FUTURE RESEARCH

6.1 Conclusions

6.1.1 Objective 1: Describe the differences in terms of Demographics, the Effort-Reward Imbalance, Over-commitment and the Ergonomic Risk Factors in VDU users in the MSD group and the reference group

Objective 1 set out to describe the differences between VDU users in the MSD group and the reference group in terms of demographics, the Effort-Reward Imbalance Model variables including over-commitment, and ergonomic risk factors. Only the frequency of physical activity within the individual demographic variables showed any statistically significant differences between the two groups. The Effort-Reward Ratio in the MSD group, as well as in the reference group, was calculated as lower than one, which indicates that the participants perceived that the efforts made were fewer than the rewards, which is a positive sign. Nor were there any significant differences between the effort, reward and reward sub-scales between the two groups. However, over-commitment was found to differ significantly between the MSD group and the reference group, with the MSD group experiencing higher levels of over-commitment than the reference group. The ROSA scores in both the MSD group and the reference group were low enough for these two groups to fall into the low-risk category. Furthermore, no significant differences were found between the two groups in terms of the ROSA scores, and thus in terms of the ergonomic work-station set up.

6.1.2 Objective 2: Determine the relationships between Effort, Reward, Over-commitment, and the Ergonomic Risk Factors in VDU-users in the MSD group and the reference group

Objective 2 was to determine the relationship between ergonomic risk factors, the effort-reward imbalance measures, and over-commitment in VDU-users in the MSD group and the reference group. No significant relationships were found between the ROSA scores and the effort-reward imbalance measures in both the MSD group and the reference group. An investigation into which factors influenced the categorisation of the participants into the MSD group or the reference group was undertaken. From the logistic regression model generated, an increase in over-commitment was found to

be associated with classification as a member of the MSD group. An increase in the frequency of physical activity of four to five times a week contributed to the likelihood of a participant to be part of the reference group. The categorisation indicated that regular physical activity practised four to five times a week tended to increase the odds for categorisation into the reference group.

6.1.3 Objective 3: Describe the type of MSD and the associated pain beliefs using the FABQ and PBPI in VDU users in the MSD group

The prevalence rates in terms of area of pain experienced in this study mirror other studies, with the highest scores being in the neck, shoulders, lower back, and upper back, followed by the hands/wrists, elbows, knees and ankles/feet. The seven-day prevalence results showed a more even distribution in respect of the percentage of MSD per site/region as compared to the 12-month prevalence question. However, the percentages for the less prevalent sites/areas were much lower for the 12-month prevalence question.

Multi-site pain was common in this population, with 53 participants experiencing more than one site of pain. Both the FABQ-PA and FABQ-W had low median scores, below the cut-off scores, where fear-avoidance belief scores above those values could be predictive of pain and disability and an indication to change the approach to treatment. The negative mean scores of all of the PBPI sub-scores indicate that the participants did not endorse these beliefs. From these values, one could draw the conclusion that the VDU population does not entertain altered pain beliefs. However, the chronicity of the MSD could have influenced this outcome.

6.1.4 Objective 4: Determine the differences between Effort, Reward, Over-commitment, and the FABQ and PBPI scores for males and females in the MSD group

As opposed to males, females attained significantly lower reward scores on both the aggregated reward scale and the reward sub-scales of esteem, job security and promotion. Females react differently from males in respect of risk factors influencing MSD.

6.1.5 Objective 5: Determine the relationships between Effort, Reward, Over-commitment, Ergonomic Risk Factors, and the FABQ and PBPI scores in the MSD group.

The final objective was to determine the relationships between effort, reward, over-commitment, MSD, and fear-avoidance beliefs and pain beliefs in the MSD population. The negative relationship between the FABQ-W and FABQ-PA and PBPI self-blame questions whether the FABQ does in fact measure beliefs rather than indicate outcomes for pain and disability. The negative relationship between the FABQ and the PBPI sub-scores indicates the tendency of this sample population of VDU users to be lacking in pain beliefs. The FABQ-W variable, which was previously associated with over-commitment (Myhre *et al.*, 2013) was not evident in this study.

6.2 Strengths of this study

Validated outcome measures were used throughout this study. The use of these outcome measures allowed for trustworthy results and, on account of the popularity of these outcome measures, these results can be considered to be comparable to those of the existing research. The ROSA was completed by the researcher only, thus allowing for consistency in the assessments. Although not all of the data were collected on one day, the period of assessment was minimised to be contained within the relevant logistical constraints.

6.3 Clinical Recommendations

Although physiotherapists in the musculoskeletal field aim to manage MSD with well-founded clinical judgement, and on the basis of sound biomechanical principles, ergonomic advice is often also considered to be a vital part of patient management and training. Considering this study's findings, and the evidence from previous studies concerning the role of an ergonomic work-station set up and MSD, as well as the belief that MSD is caused by the former, physiotherapists should give ergonomic advice with caution. The clinical judgement of the role of the ergonomic set up and MSD, as well as the belief regarding work-station set up and MSD, should be carefully weighed against each other before advice is given to patients.

Furthermore, assessments of intrinsic over-commitment in MSD sufferers should be evaluated. Long-term occupational health initiatives beyond the scope of MSD, should

include assessments of over-commitment and interventions to address individuals at risk of burnout and associated health concerns.

Clinicians should be aware that females have different reactions and outcomes to the risk of MSD. Interventions to address pain beliefs in the VDU user should be carried out only when individual assessments have established that such beliefs do in fact exist. No significant relationships were found in this research study between effort, reward, over-commitment, and the FABQ and PBPI measures.

6.4 Recommendations for Future Studies

Future studies should include assessments of pain beliefs in the VDU user suffering from chronic MSD. Alternatively, generic risk assessments for MSD could be included in future research, as in the case of applications of the Keele MSK STarTBack screening tool. A prospective study to establish the causes of over-commitment in the South African VDU-user population could also be embarked upon. One could do further analysis and larger study sample for multi-site pain in work-related MSD.

Future research could include intervention protocols in the work place based on further test results. Future research concerning the South African population and in terms of more specific interventions to manage psychosocial and ergonomic risk factors could also be performed. This could include assessments of these effects on the burden of disease and the cost to the economy, while changes in the quality of life of the MSD sufferers could also be established. Clinicians and policy makers should be taught to be vigilant in terms of the type of information disseminated to MSD sufferers and could assist in the prevention and more holistic management of MSD, besides creating awareness in respect of the propagation of adverse health beliefs.

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APPENDICES

Appendix A: **Information Sheet and Consent Form for Participants**

Faculty of Health Sciences · Private Bag 3, Wits, 2050, South Africa
Tel: +27 11 717 2014 · Fax: + 27 86 663 5776 · E-mail: benita.olivier@wits.ac.za · Staff profile: http://www.wits.ac.za/staff/benita.olivier.htm

INFORMATION DOCUMENT: Visual Display Unit User

Study title: Musculoskeletal Disorders, Work-related factors and Pain Beliefs among Visual-Display-Unit Users

Dear Computer User

I, Vanessa Redivo, am doing a research study on the pain that office workers using computers/laptops may experience in their joints, muscles and nerves, as well as other contributing factors to their pain.

In this study, I want to learn more about what factors contribute to the pain and symptoms that office workers may experience when using visual display screens, like computers and laptops.
Studies have shown that work factors (e.g. work demands), your work station (ergonomic set up) and also psychosocial factors all play a role. Psychosocial factors may include stress, effort and ideas about pain. In this study, I wish to assess these factors that affect you, the worker. I will be using an online questionnaire and evaluating your work station and grading it.
This is an exciting area of research with almost 80% of workers using computers/laptops every day!
I would be most grateful if you would be willing to participate in this research project and potentially bring greater clarity to this field. The project is scheduled to commence in January 2018 and to be completed by June 2019.

Who is eligible to take part in this study?
Male and female office workers that spend more than four hours a day at a computer/laptop and at least 12 months in your current or a similar job. Office workers who have had previous surgery in respect of any bones, joints or muscles in the last two years cannot participate. Employees who are undergoing any mental health treatment, including but not limited to depression and anxiety, may not participate.

What is involved in the study?
Participation includes filling in an online questionnaire about yourself and your work. While you complete the online questionnaire, I will observe you in your work station and complete a work-station assessment. Following the work-station assessment, and once the online questionnaire has been completed, I will give you feedback relating to any work-station adjustments that could benefit you should they be indicated.

The whole process should not take longer than 30 minutes, and as little as 15 minutes of time off work.

Participation is voluntary and refusal to participate will not involve any penalty or loss of benefits to which you are otherwise entitled. You may withdraw from this study at any time without suffering any repercussions.

Are there any risks in participating in this study?
You will not be exposed to any risks other than the risk that you are normally exposed to when you are at work.

What are the benefits of participating in this study?
Non-identifiable, generalised results will be made available to all participants at the end of the study. No monetary reward will be given for participating in this study. Should there be an indication to adjust the work station, you will be informed about such measures.

Will information be handled as confidential?
Efforts will be made to keep personal information confidential. Absolute confidentiality cannot be guaranteed. Personal information may be disclosed if required by law. To ensure confidentiality of participants, each computer/laptop user will be assigned a study number. The key to the study numbers assigned will be kept by the researcher only. Names of participants are to be written only on the consent form and not on the questionnaire. Additionally, consent forms are to be kept separately from the questionnaires. All information will be used only for the purpose intended in this study only.

For further information, you are welcome to contact me on 0845882116 or send an email to vanessasred@gmail.com

For more information on, or for the reporting of ethical concerns, you may contact the chair of the Human Research Ethics Committee of the University of the Witwatersrand: Professor Cleaton Jones; Tel: 011-717-2700

Kind regards

Vanessa Redivo
Physiotherapy Department
University of the Witwatersrand

CONSENT FORM for visual-display-unit users

Study title: Musculoskeletal Disorders, Work-related factors and Pain Beliefs among Visual-Display-Unit Users

I_____ hereby agree to participate in the study as described to me in the information sheet. I hereby agree to complete the required questionnaire and consent to the assessment of my work station.

I am aware that I will not be exposed to any additional risks other than those usually experienced during working hours and that I can withdraw from the study at any time without suffering any repercussions. I understand that there are no monetary rewards for my participation and that participation is voluntary and I am not in any way obliged to take part.

Signature of participant _____

Date _____

Signature of researcher _____

Appendix B: **Amended Cultural and Psychosocial Influences on Disability (CUPID) Questionnaire**

Section one: Personal Information

1. Date of birth:
2. Sex:
3. Are you right or left handed?
4. How old were you when you finished full time education?
5. How many times a week and for how long do you part take in physical activity or exercise?
6. When last did you take leave, and for how long?

Section Two: Work

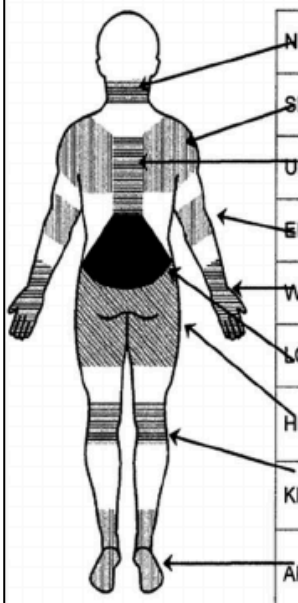
8. What is your main occupation?
9. Under which department do you fall?
10. How many years have you been working?
    a. Less than a year
    b. 1-5 years
    c. More than 5 years
11. How many hours per week do you normally work at this job?
12. How many hours a day do you work in front of a visual display unit/screen?
13. Do you have a desk top or laptop?

Appendix C: **Effort-Reward Imbalance and Over-commitment Questionnaire**

		Strongly disagree	Disagree	Agree	Strongly Agree
ERI1	I have constant time pressure due to heavy work load.				
ERI2	I have many interruptions and disturbances while performing my job.				
ERI3	I have a lot of responsibility in my job.				
ERI4	I am often pressured to work overtime.				
ERI5	My job is physically demanding.				
ERI6	Over the past few years, my job has become more and more demanding.				
ERI7	I receive the respect I deserve from my superior or a respective relevant person.				
ERI8	I experience adequate support in difficult situations.				
ERI9	I am treated unfairly at work.				
ERI10	My job promotion prospects are poor.				
ERI11	I have experienced, or I expect to experience an undesirable change in my work situation.				
ERI12	My employment security is poor.				
ERI13	My current occupational position adequately reflects my education and training.				
ERI14	Considering all my efforts and achievements, I receive the respect and prestige I deserve at work.				
ERI15	Considering all my efforts and achievements, my job promotion prospects are adequate.				
ERI16	Considering all my efforts and achievements, my salary/income is adequate.				
OC1	I get easily overwhelmed by time pressure at work.				

OC2	As soon as I get up in the morning I start thinking about work.				
OC3	When I get home, I can easily relax and 'switch off' work.				
OC4	People close to me say I sacrifice too much for my job.				
OC5	Work rarely lets me go, it is still on my mind when I go to bed				
OC6	If I postpone something that I was supposed to do today, I'll have trouble sleeping at night.				

Appendix D: **Nordic Musculoskeletal Questionnaire, and follow up questions**



	Have you at any time during the last 12 months had trouble (such as ache, pain, discomfort, numbness) in:	During the last 12 months have you been prevented from carrying out normal activities (e.g. job, housework, hobbies) because of this trouble in:	During the last 12 months have you seen a physician for this condition:	During the last 7 days have you had trouble in:
NECK	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
SHOULDERS	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
UPPER BACK	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
ELBOWS	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
WRISTS/ HANDS	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
LOWER BACK	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
HIPS/ THIGHS	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
KNEES	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes
ANKLES/ FEET	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes	☐ No ☐ Yes

Yes to any in Column 1, the following question would follow to each yes:

1. What type medical treatment, if any, are you receiving?
2. Were any of your symptoms caused by injuries/incidents outside of work? If yes, what?

Appendix E: **Fear-avoidance Beliefs Questionnaire**

Here are some of the things other patients have told us about their pain. For each statement please circle the number from 0 to 6 to indicate how much physical activities such as bending, lifting, walking or driving affect or would affect your pain.

	Completely Disagree			Unsure			Completely Agree
	0	1	2	3	4	5	6
1. My pain was caused by Physical activity.							
2. Physical activity makes my pain worse.							
3. Physical activity might harm my body.							
4. I should not do physical activities which (might) harm my body.							
5. I cannot do physical activities which (might) make my pain worse.							

The following statements are about how your normal work affects or would affect your pain.

	Completely Disagree			Unsure			Completely Agree
	0	1	2	3	4	5	6
6. My pain was caused by my work or by an accident at work.							
7. My work aggravated my pain.							
8. I have a claim for compensation for my pain.							
9. My work is too heavy for me.							
10. My work makes or would make my pain worse.							
11. My work might harm my body.							
12. I should not do my regular work with my present pain.							

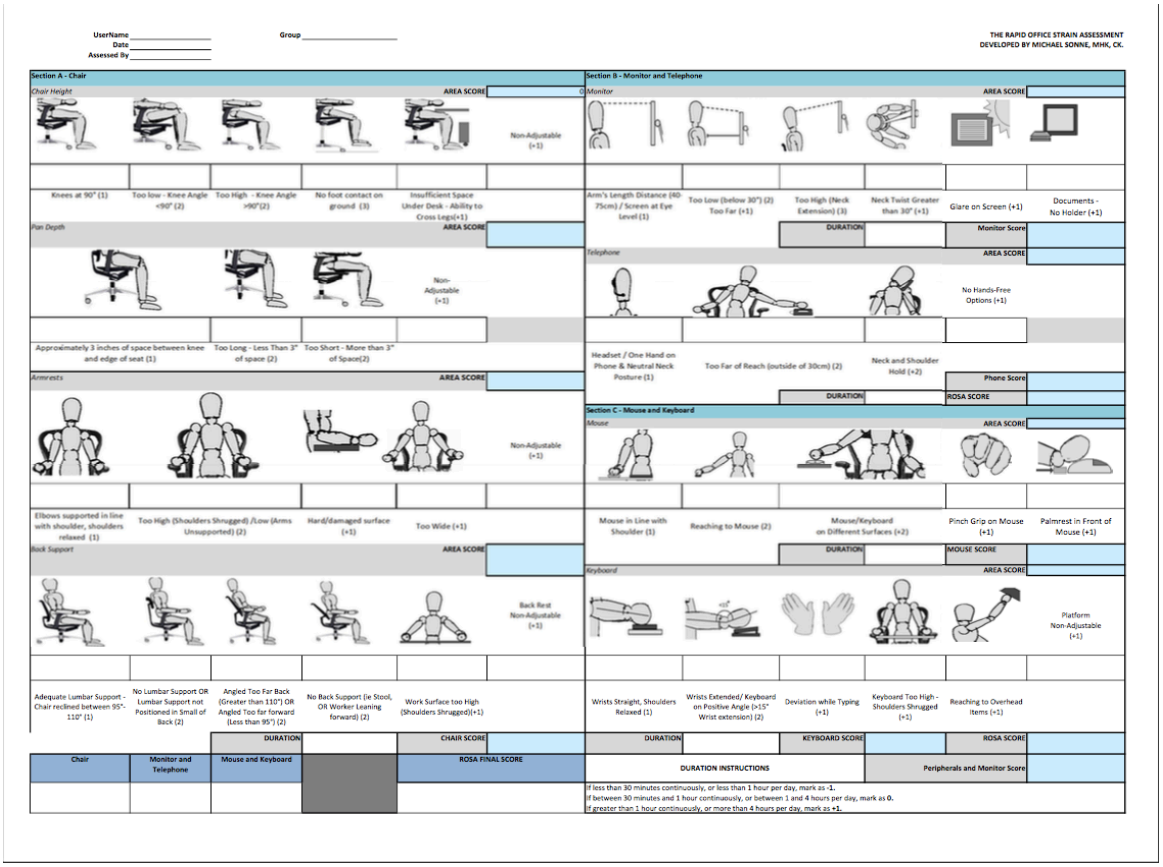
13. I cannot do my work with my present pain.							
14. I cannot do my normal work until my pain is treated.							
15. I do not think that I will be back to my normal work within 3 months							
16. I do not think that I will ever be able to go back to work							

Appendix F: **Pain Beliefs Perceptions Inventory**

Please indicate the degree to which you agree or disagree with each of the following statements. Simply circle the number that corresponds with your level of agreement.

Statement	Strongly Disagree	Disagree	Agree	Strongly Agree
1. No one's been able to tell me exactly why I'm in pain.	-2	-1	1	2
2. I used to think my pain was curable but now I'm not so sure.	-2	-1	1	2
3. There are times when I am pain-free	-2	-1	1	2
4. My pain is confusing to me.	-2	-1	1	2
5. My pain is here to stay.	-2	-1	1	2
6. I am continuously in pain.	-2	-1	1	2
7. If I am in pain, it is my own fault.	-2	-1	1	2
8. I don't know enough about my pain	-2	-1	1	2
9. My pain is a temporary problem in my life	-2	-1	1	2
10. It seems like I wake up with pain and go to sleep with pain.	-2	-1	1	2
11. I am the cause of my pain.	-2	-1	1	2
12. There is a cure for my pain.	-2	-1	1	2
13. I blame myself if I am in pain.	-2	-1	1	2
14. I can't figure out why I'm in pain.	-2	-1	1	2
15. Someday I'll be 100% pain-free again.	-2	-1	1	2
16. My pain varies in intensity but is always with me.	-2	-1	1	2

Appendix G: **Rapid Office Strain Assessment**



UserName _____ Group _____

Date _____

Assessed By _____

THE RAPID OFFICE STRAIN ASSESSMENT
DEVELOPED BY MICHAEL SONNE, MHK, CK.

Section A - Chair

Chair Height — AREA SCORE

Knees at 90° (1) | Too low - Knee Angle <90° (2) | Too High - Knee Angle >90°(2) | No foot contact on ground (3) | Insufficient Space Under Desk - Ability to Cross Legs(+1) | Non-Adjustable (+1)

Pan Depth — AREA SCORE

Approximately 3 inches of space between knee and edge of seat (1) | Too Long - Less Than 3" of space (2) | Too Short - More than 3" of Space(2) | Non-Adjustable (+1)

Armrests — AREA SCORE

Elbows supported in line with shoulder, shoulders relaxed (1) | Too High (Shoulders Shrugged) /Low (Arms Unsupported) (2) | Hard/damaged surface (+1) | Too Wide (+1) | Non-Adjustable (+1)

Back Support — AREA SCORE

Adequate Lumbar Support - Chair reclined between 95°-110° (1) | No Lumbar Support OR Lumbar Support not Positioned in Small of Back (2) | Angled Too Far Back (Greater than 110°) OR Angled Too far forward (Less than 95°) (2) | No Back Support (ie Stool, OR Worker Leaning forward) (2) | Work Surface too High (Shoulders Shrugged)(+1) | Back Rest Non-Adjustable (+1)

DURATION | CHAIR SCORE

Chair	Monitor and Telephone	Mouse and Keyboard		ROSA FINAL SCORE

Section B - Monitor and Telephone

Monitor — AREA SCORE

Arm's Length Distance (40-75cm) / Screen at Eye Level (1) | Too Low (below 30°) (2) Too Far (+1) | Too High (Neck Extension) (3) | Neck Twist Greater than 30° (+1) | Glare on Screen (+1) | Documents - No Holder (+1)

DURATION | Monitor Score

Telephone — AREA SCORE

Headset / One Hand on Phone & Neutral Neck Posture (1) | Too Far of Reach (outside of 30cm) (2) | Neck and Shoulder Hold (+2) | No Hands-Free Options (+1)

DURATION | Phone Score | ROSA SCORE

Section C - Mouse and Keyboard

Mouse — AREA SCORE

Mouse in Line with Shoulder (1) | Reaching to Mouse (2) | Mouse/Keyboard on Different Surfaces (+2) | Pinch Grip on Mouse (+1) | Palmrest in Front of Mouse (+1)

DURATION | MOUSE SCORE

Keyboard — AREA SCORE

Wrists Straight, Shoulders Relaxed (1) | Wrists Extended/ Keyboard on Positive Angle (>15° Wrist extension) (2) | Deviation while Typing (+1) | Keyboard Too High - Shoulders Shrugged (+1) | Reaching to Overhead Items (+1) | Platform Non-Adjustable (+1)

DURATION | KEYBOARD SCORE | ROSA SCORE

DURATION INSTRUCTIONS

If less than 30 minutes continuously, or less than 1 hour per day, mark as -1.
If between 30 minutes and 1 hour continuously, or between 1 and 4 hours per day, mark as 0.
If greater than 1 hour continuously, or more than 4 hours per day, mark as +1.

Peripherals and Monitor Score

RAPID OFFICE STRAIN ASSESSMENT

EMPLOYEE NAME: _____
DATE: _____
ASSESSED BY: _____

ROSA SCORING INSTRUCTIONS

1. Add Seat Pan and Seat Depth scores together to receive Section A vertical Axis Score. Add Arm Rest and Back Rest scores together to receive the vertical axis score. Using these scores, follow the scoring chart to receive the Chair Score. Add the appropriate duration score based on the amount of time the worker spends in the chair per day.
2. Add the score for the Monitor with the appropriate duration score to receive the value for the horizontal axis in Section B. Add the telephone score together plus the appropriate duration score to receive the vertical axis for Section B. Using these scores, follow the scoring chart to receive the Section B score.
3. Add the score for the keyboard to the appropriate duration score to receive the value for the horizontal axis in Section C. Add the score of the mouse to the appropriate duration score to receive the vertical axis for Section C. Using these scores, follow the scoring chart to receive the Section C score.
4. Use the score from step 2 to receive the score for the vertical axis in the peripheral and monitor section. Use the score from step 3 to receive the score for the horizontal axis in the peripheral and monitor section.
5. Use the score from Step 1 (Section A) to receive the value for the vertical axis in the grand score chart. Use the score from step 4 to receive the score for the horizontal axis in the grand score chart. Using these two scores, find the coresponding Grand ROSA score.

SECTION A SCORE

seat pan height /depth	Arm Rest and Back Support 2	3	4	5	6	7	8	9
2	2	2	3	4	5	6	7	8
3	2	2	3	4	5	6	7	8
4	3	3	3	4	5	6	7	8
5	4	4	4	4	5	6	7	8
6	5	5	5	5	6	7	8	9
7	6	6	6	7	7	8	8	9
8	7	7	7	8	8	9	9	9

SECTION B SCORE

Phone	Monitor 0	1	2	3	4	5	6	7
0	1	1	1	2	3	4	5	6
1	1	1	2	2	3	4	5	6
2	1	2	2	3	3	4	6	7
3	2	2	3	3	4	5	6	8
4	3	3	4	4	5	6	7	8
5	4	4	5	5	6	7	8	9
6	5	5	6	7	8	8	9	9

SECTION C SCORE

Mouse	Keyboard 0	1	2	3	4	5	6	7
0	1	1	1	2	3	4	5	6
1	1	1	2	3	4	5	6	7
2	1	2	2	3	4	5	6	7
3	2	3	3	3	5	6	7	8
4	3	4	4	5	5	6	7	8
5	4	5	5	6	6	7	8	9
6	5	6	6	7	7	8	8	9
7	6	7	7	8	8	9	9	9

MONITOR AND PERIPHERALS SCORE

Monitor and Telephone	Mouse and Keyboard 1	2	3	4	5	6	7	8	9
1	1	2	3	4	5	6	7	8	9
2	2	2	3	4	5	6	7	8	9
3	3	3	3	4	5	6	7	8	9
4	4	4	4	4	5	6	7	8	9
5	5	5	5	5	5	6	7	8	9
6	6	6	6	6	6	6	7	8	9
7	7	7	7	7	7	7	7	8	9
8	8	8	8	8	8	8	8	8	9
9	9	9	9	9	9	9	9	9	9

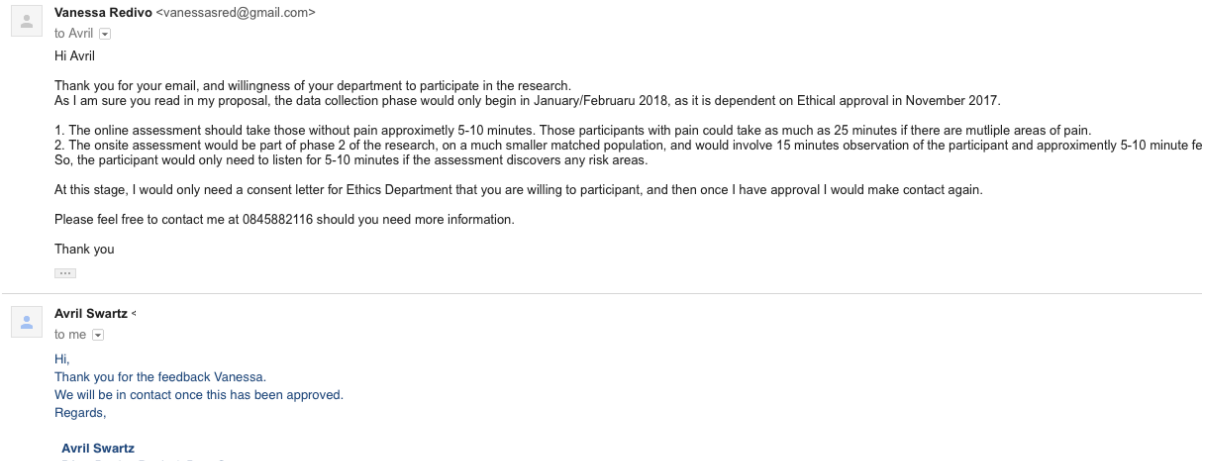
Peripherals and Monitor

Chair	1	2	3	4	5	6	7	8	9	10
1	1	2	3	4	5	6	7	8	9	10
2	2	2	3	4	5	6	7	8	9	10
3	3	3	3	4	5	6	7	8	9	10
4	4	4	4	4	5	6	7	8	9	10
5	5	5	5	5	5	6	7	8	9	10
6	6	6	6	6	6	6	7	8	9	10
7	7	7	7	7	7	7	7	8	9	10
8	8	8	8	8	8	8	8	8	9	10
9	9	9	9	9	9	9	9	9	9	10
10	10	10	10	10	10	10	10	10	10	10

ROSA FINAL SCORE

Appendix H: **Consent from human resource department for access to participants**

Company 1:



Vanessa Redivo <vanessasred@gmail.com>
to Avril

Hi Avril

Thank you for your email, and willingness of your department to participate in the research.
As I am sure you read in my proposal, the data collection phase would only begin in January/Februaru 2018, as it is dependent on Ethical approval in November 2017.

1. The online assessment should take those without pain approximetly 5-10 minutes. Those participants with pain could take as much as 25 minutes if there are mutliple areas of pain.
2. The onsite assessment would be part of phase 2 of the research, on a much smaller matched population, and would involve 15 minutes observation of the participant and approximently 5-10 minute fe
So, the participant would only need to listen for 5-10 minutes if the assessment discovers any risk areas.

At this stage, I would only need a consent letter for Ethics Department that you are willing to participant, and then once I have approval I would make contact again.

Please feel free to contact me at 0845882116 should you need more information.

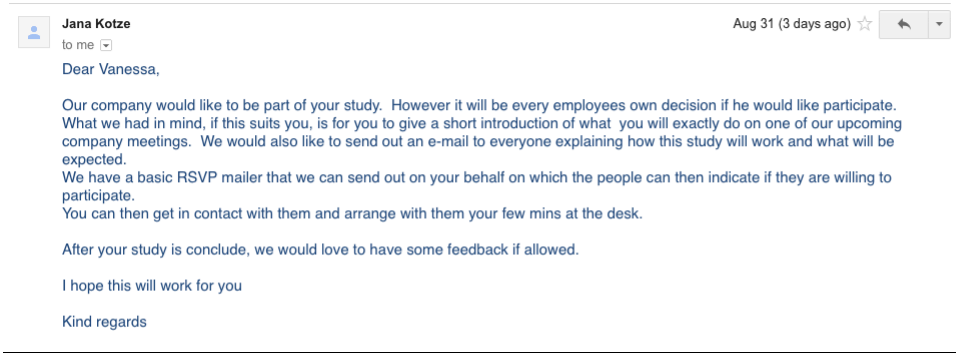
Thank you

Avril Swartz <
to me

Hi,
Thank you for the feedback Vanessa.
We will be in contact once this has been approved.
Regards,

Avril Swartz

Company 2:



Jana Kotze Aug 31 (3 days ago)
to me

Dear Vanessa,

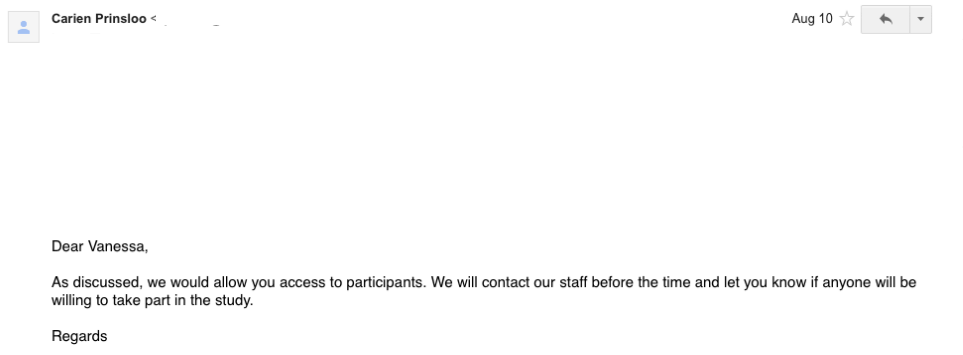
Our company would like to be part of your study. However it will be every employees own decision if he would like participate.
What we had in mind, if this suits you, is for you to give a short introduction of what you will exactly do on one of our upcoming company meetings. We would also like to send out an e-mail to everyone explaining how this study will work and what will be expected.
We have a basic RSVP mailer that we can send out on your behalf on which the people can then indicate if they are willing to participate.
You can then get in contact with them and arrange with them your few mins at the desk.

After your study is conclude, we would love to have some feedback if allowed.

I hope this will work for you

Kind regards

Company 3:



Carien Prinsloo < Aug 10

Dear Vanessa,

As discussed, we would allow you access to participants. We will contact our staff before the time and let you know if anyone will be willing to take part in the study.

Regards

Appendix I: **Ethical Clearance Certificate**

R14/49 Ms Vanessa Redivo

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M171064

NAME: (Principal Investigator)	Ms Vanessa Redivo
DEPARTMENT:	Physiotherapy
PROJECT TITLE:	Musculoskeletal Disorder, Work Related Factors and Pain Beliefs among Visual-Display-Unit Users
DATE CONSIDERED:	27/10/2017
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Prof Benita Olivier
APPROVED BY:	Professor P. Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	15/12/2017

This clearance certificate is valid for 5 years from 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. I/We fully understand the conditions under which I am/we are authorised 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 resubmit to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. in this case, the study was initially review October and will therefore be due in the month of October each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature Date 01/11/2017

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix J: **Turn-it-in Report**

ORIGINALITY REPORT

%14	%10	%9	%3
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of Witwatersrand Student Paper	<%1
2	"Work Stress and Health in a Globalized Economy", Springer Nature, 2016 Publication	<%1
3	link.springer.com Internet Source	<%1
4	Lukas R.C. Dekker, Pepijn H. van der Voort, Timothy A. Simmers, Xander A.A.M. Verbeek et al. "New image processing and noise reduction technology allows reduction of radiation exposure in complex electrophysiologic interventions while maintaining optimal image quality: A randomized clinical trial", Heart Rhythm, 2013 Publication	<%1
5	www.ncbi.nlm.nih.gov Internet Source	<%1
	helda.helsinki.fi	