

A simple ergonomic intervention for neck and upper back musculoskeletal pain in computer users

by
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Declaration

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Abstract

Background: The use of computers at school, university, work and for social media is growing and whilst neck pain is common in the general population, computer users have an even higher prevalence. Incorrect workstation ergonomics have been identified as a risk factor for the development of neck pain in computer workers.

Aims: To assess the effect of adjusting chair and monitor height of a female office worker's computer workstation on work related neck and upper back pain intensity, comfort of her sitting posture and disability.

Methods: An N=1 study was conducted using the A-B-C design consisting of a computer workstation adjustment involving chair and monitor height of a female office worker. The effect of the intervention was evaluated using the Visual Analogue Scale (VAS) to measure neck and upper back pain intensity and comfort of sitting position, and the Neck Disability Index to measure disability. The effect of the intervention was assessed over the three phases, consisting of four weeks each. During these phases, the participant could continue with her usual computer work. The results were compiled and tabulated.

Results: A reduction in neck and upper back pain intensity as well as an increase in sitting comfort position were found. However these improvements were not statistically or clinically significant. The effect size for pain intensity was 0.76 and for sitting comfort 0.21. The participant reported no disability as measured by the Neck Disability Index, at the start and at the end at the end of the study.

Conclusion: The vertical adjustment of this female office worker's chair and monitor height according to her anthropometrics improved neck and upper back pain intensity and comfort of sitting position. This ergonomic workstation intervention could form part of a practical management option for computer users with neck and upper back pain. Further research is recommended to establish whether these findings are generalizable to the wider community of computer users.

Opsomming

Probleemstelling: Die gebruik van rekenaars by skole, universiteite, werksplekke en vir sosiale doeleindes neem toe. Nek pyn kom dikwels in die algemene bevolking voor, maar dit is meer prevalent in rekenaargebruikers. 'n Werkstasie wat nie ergonomies korrek opgestel is nie, is geïdentifiseer as 'n risikofaktor vir die ontwikkeling van nekpyn in rekenaar werkers.

Doelwitte: Om te bepaal of aanpassings in die stoel- en beeldskerm hoogte van 'n vroulike kantoor werker se rekenaar werkstasie, 'n effek het op werksverwante nek en boonste rug pyn, sitgemak en funksionele vermoë.

Metode: Die N=1 studie met 'n A-B-C ontwerp is onderneem en het bestaan uit n rekenaar werkstasie aanpassing waarby die hoogte van die stoel en beeldskerm van 'n vroulike rekenaargebruiker aangepas is. Die effek van die intervensie is geëvalueer deur middel van die visueel analogeskaal (VAS) om pyn en sitgemak te bepaal; en die Nek Ongeskiktheids Indeks (NOI) om gestremtheid te bepaal. Die effek van die intervensie is oor drie fases, wat elk bestaan het uit vier weke, geëvalueer. Gedurende die fases, kon die deelnemer met haar gewone rekenaarwerk voortgaan. Die resultate is saamgestel en getabelleer.

Resultate: Daar was 'n vermindering in die intensiteit van nekpyn, boonste rug pyn en die sitgemak van die individu het ook verbeter. Hierdie verbetering was egter nie statisties of klinies betekenisvol nie. Die effek grootte vir pyn intensiteit was 0.76 en vir sitgemak was 0.21. Die deelnemer het geen gestremtheid gerapporteer, soos gemeet met die NOI met aanvangs van die studie of teen die einde van die studie nie.

Gevolgtrekking: Die vertikale hoogte-aanpassing van die stoel en beeldskerm van hierdie vroulike rekenaar werker volgens haar antropometrie het bygedra tot 'n verbetering in nek en boonste rug pyn, asook sitgemak. Hierdie ergonomiese werkstasie intervensie kan deel vorm van die praktiese hantering van nek en boonste rug pyn in rekenaargebruikers. Verdere navorsing word aanbeveel om te bepaal of hierdie bevindinge veralgemeenbaar is na die wyer gemeenskap van rekenaarverbruikers.

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Table of Contents

Declaration	ii
Abstract	iii
Opsomming	iv
Acknowledgements	v
Table of Contents	vi
List of Appendices	viii
List of Tables	ix
List of Figures	x
List of Abbreviations	xi
Chapter 1 Literature Review	1
1.1. Introduction	1
1.2. Prevalence and Incidence of WRNP in Computer Workers	1
1.3. Aetiology and Risk Factors of WRNP in Computer Workers	3
1.3.1. Individual Risk Factors	3
1.3.2. Organisational workplace factors	5
1.3.3. Work-related physical factors	7
1.4. Interventions for WRNP in Computer Workers	16
1.4.1. Multi factorial interventions.....	17
1.4.2. Monitor height interventions	20
1.4.3. Seat height interventions.....	20
1.5. Conclusion	21
Chapter2: Journal Article	22
2.1. Abstract	22
2.2. Introduction	23
2.3. Methodology.....	24
2.3.1. Study design	24

2.3.2. Eligibility criteria and participant recruitment	25
2.3.3. Screening.....	25
2.3.4. Outcome measures.....	26
2.3.5. Study procedure.....	27
2.3.6. Data analysis.....	29
2.4. Results	29
2.4.1. Participant description	30
2.4.2. Visual Analogue Scales for pain intensity and comfort of sitting	34
2.4.3. Neck Disability Index.....	36
2.4.4. Analysis of the end of phase and exit questionnaires	36
2.5. Discussion.....	37
2.6. Conclusion	42
Article References.....	44
Chapter 3: Summary	49
3.1. Background.....	49
3.2. Contribution to the body of knowledge	49
3.3. Study description.....	50
3.4. Clinical Implications.....	51
3.5. Strengths, Limitations and recommendations	53
Chapter 4: Conclusion	54
References.....	55
Appendices.....	63

List of Appendices

Appendix 1: Journal Guidelines.....	63
Appendix 2: Ethics Approval Letter.....	64
Appendix 3: Signed Informed Consent Form	65
Appendix 4: Screening Questionnaire	68
Appendix 5: Participant's Workstation Adjustment	70
Appendix 6: The Neck Disability Index.....	71
Appendix 7: Entry Questionnaire.....	73
Appendix 8: Outcome Measures Questionnaire.....	78
Appendix 9: End of Phase Questionnaire	79
Appendix 10: Exit Questionnaire	80

List of Tables

Table 1.1: Risk Factors for WRNP.....	3
Table 1.2: Multi-factorial interventions.....	17
Table 1.3: Systematic reviews on ergonomic interventions.....	19
Table 2.1: Workstation measurements and adjustments	30
Table 2.2: Summary of the subjective examination	32
Table 2.3: Summary of the objective examination	33
Table 2.4: Table displaying means and variances of VAS pain and VAS comfort	35
Table 2.5: Summary of data from the end of phase questionnaires	37

List of Figures

Figure 2.1: The study procedure outline	27
Figure 2.2: Photographs of participant's habitual (top) and adjusted (bottom) workstation	31
Figure 2.3: VAS pain and means for phases A, B and C.....	34
Figure 2.4: VAS comfort and means for phases A, B and C.....	35
Figure 2.5: Graph of VAS pain, VAS comfort and means for phases A, B and C	36

List of Abbreviations

MSD	Musculoskeletal disorders
MSS	Musculoskeletal symptoms
WRNP	Work related neck pain
VAS	Visual Analogue Scale
STarT	Screening tool to alert doctors to the right treatment
MCID	Minimum clinically important difference
NDI	Neck Disability Index
RULA	Rapid Upper Limb Assessment Score
SD	Standard deviation

Chapter 1 Literature Review

1.1. Introduction

This review aimed to identify studies that have attempted to determine the risk factors associated with computer users developing neck and upper back musculoskeletal disorders (MSD) and musculoskeletal symptoms (MSS). A secondary aim was to ascertain whether any interventions have proved effective in this population. As the cervical area can refer into the upper back, the upper back was included when mentioned in the studies. Numerous studies report on the neck and shoulder areas together, and therefore these were also included in this study, whereas the upper limb or arm were not included.

The areas of the neck, upper back and shoulders have been combined and the term work-related neck pain (WRNP) is used in this article for brevity. "Computer" refers to a desktop, laptop or notebook personal computer which includes a keyboard and a mouse.

The following databases were searched: CINAHL; Science Direct; Pedro; and PubMed. Search Terms used in various combinations included *neck pain, cervical pain, upper back pain, computer user, computer worker, workstation adjustment, ergonomic intervention, monitor height, screen height, chair height and seat height*. The search was conducted between May 2013 and September 2014, with additional articles gleaned from the reference lists of articles found.

1.2. Prevalence and Incidence of WRNP in Computer Workers

Globally, the past decade has seen a 25% increase in people suffering from musculoskeletal conditions, a common cause of chronic disability, which makes up two percent of the global disease burden (Khan et al. 2012). Neck pain is common in the general population with an annual prevalence of between 30% and 50% (Hogg-Johnson et al. 2008), whereas a higher percentage of above 50% is found in workers of various occupations, accounting for a substantial burden of disability in workers annually (Cote et al. 2008). The cost of work related upper limb disorders in the

European Union alone is estimated to be between 0.5% and 2% of the gross national product (Hoe et al. 2012).

Office and computer workers have been reported as having the highest incidence of neck disorders in the working population with 63% prevalence (Cote et al. 2008). Tornqvist (2009) found an incidence rate of 67 and 41 cases per 100 person years for neck and shoulder cases respectively in a study on professional computer users. These figures suggest a causal relationship, and previous literature reviews, based mainly on longitudinal studies, did point to an association between computer work and musculoskeletal complaints in the neck and upper back (Gerr et al. 2006; Griffiths et al. 2012; Ijmker et al. 2007). As more prospective studies have emerged, subsequent reviews are finding the evidence to be less conclusive (Aas et al. 2011; Andersen et al. 2011; Driessen et al. 2010; Wærsted et al. 2010)

Regarding the future workforce, children are exposed to ever-earlier computer-related activities (Green 2008). At schools globally the implementation of information technology is growing (Smith et al. 2009). A similar trend is seen in South Africa, where every school in the Western Cape is being equipped with computer laboratories, exposing learners to increasing hours at the computer (Smith et al. 2009). University students are part of the “Y” generation and laptops have become essential to their academic and social lives (Singh et al. 2014). Within the population, senior school children and young adults are the predominant users of computers (Burgess-Limerick et al. 1999; Straker et al. 2008). Smith et al. (2009) found that 47.61% of a sample of adolescents suffered with neck pain and headaches, with the only predictor being hours of computer use. It has been stated that symptoms during adolescence can predict pain in adulthood; therefore the future workforce is already “sick” with WRNP before starting their working life (Green 2008).

The high prevalence of WRNP among computer workers can result in personal suffering and financial costs, as well as a burden on the employer in terms of absenteeism from work (Aas et al. 2011). It is therefore imperative to determine and understand the risk factors associated with WRNP as well as which interventions have been proven to be successful.

1.3. Aetiology and Risk Factors of WRNP in Computer Workers

The origin of neck pain in computer users is not yet fully understood, but in the absence of a definite pathology such as arthritis or trauma, the aetiology of neck pain in computer users is most likely multifactorial and associated with, and influenced by, individual psychosocial, and work-related factors, both organisational and physical (Cote et al. 2008; Paksaichol et al. 2012). Table 1.1 summarises the risk factors found to contribute to WRNP.

Table 1.1: Risk Factors for WRNP

Individual Risk Factors	Work-related Risk Factors	
	Organisational	Physical
<ul style="list-style-type: none"> • female gender • age • physical inactivity • history of neck trauma • history of previous neck symptoms • personality traits • psychosocial factors 	<ul style="list-style-type: none"> • job demands • job control • social support • work style 	<ul style="list-style-type: none"> • duration of computer work • static awkward postures • monitor height • document holder • desk height • keyboard and mouse use • seat height

1.3.1. Individual Risk Factors

Gender

Several studies have found female gender to be associated with neck pain in computer users (Cagnie et al. 2007; Griffiths et al. 2007; Janwantanakul et al. 2008; Paksaichol et al. 2012). Some studies have hypothesised that lower strength of the shoulder muscles and the smaller stature of females may be responsible for this association (Korhonen et al. 2003). Differences in work tasks and work techniques, such as women using the mouse with more force and greater range of movement than men, may further explain the gender difference (Jensen et al. 2002). Korhonen (2003) concluded that the women in their study had more monotonous computer

tasks than the men, resulting in more static postures and repetitive movements. Another study concluded that cultural differences can result in women reporting more symptoms than men (Sillanpaa et al. 2003).

Age

Other than gender, increased age has also been associated with a higher risk of neck pain (Cote et al. 2008). However, one study reports a reverse U-shaped association between age and the risk of neck pain in computer users. Cagnie et al. (2007) report that there appears to be an increased risk of neck pain until the age of 50, possibly resulting from degeneration of the cervical and upper thoracic spines, and a subsequent decrease thereafter, explained by an increase in other illnesses. Janwantanakul et al. (2008) found an association between the prevalence of upper back MSS and workers younger than 30 years, which led them to conclude that neck pain in young office workers may be as a result of lack of experience in coping with physical and psychosocial job demands, or they may spend longer hours at the computer than older colleagues.

Physical inactivity, history of neck trauma and history of neck symptoms

Other individual risk factors for neck and shoulder MSS include physical inactivity (Cagnie et al. 2007; Korhonen et al. 2003), a history of neck trauma (Brandt et al. 2004; Johnston et al. 2009) and a previous history of neck pain symptoms (Cote et al. 2008; Eltayeb et al. 2011; Paksaichol et al. 2012).

Psychosocial factors and personality traits

Psychosocial factors have been found to have an association with WRNP (Eltayeb et al. 2011; Kiss et al. 2012; Wahlstrom 2005). Wahlstrom (2004) found perceived muscular tension to be associated with an increased risk of developing neck pain among computer users, while perceived stress and psychological distress have also been linked to WRNP (Cho et al. 2012; Evans and Patterson 2000). Johnston et al. (2009) reported that workers with neck pain and consequent disability demonstrated higher negative affectivity scores than both workers with no disability or controls. Further evidence supporting a positive association between high psychological job strain and the risk of neck pain is found in a number of studies (Bongers et al. 2006; Brandt et al. 2004; Korhonen et al. 2003). Certain personality traits may also

contribute to WRNP pain. Bongers et al. (2006) mentioned Type A behaviour (a behaviour pattern associated with individuals who are highly competitive and work compulsively to meet deadlines), neurotic perfectionist traits, introversion and illness behaviour to have an influence on neck and upper limb MSS (Bongers et al. 2006). Individual psychosocial factors and personality traits thus have an influence on how an individual responds to work-related psychosocial factors.

As most individual risk factors are non-modifiable, recommendations to decrease the individual risk factors should especially be implemented for those “at risk” and include:

- increasing physical activity;
 - improving skills;
 - learning improved work style;
 - learning relaxation;
 - using biofeedback to monitor muscular tension;
 - cognitive training; and
 - individual counselling to reduce the stress response.
- (Bongers et al. 2006).

1.3.2. Organisational workplace factors

Work-related psychosocial factors are often referred to as organisational workplace factors and encompass the worker’s perceptions or beliefs about the way their work environment is organised. As tasks become increasingly computerised (administrative tasks, electronic communication, information storage and document handling) organisations benefit with increased efficiency of work processes, increased productivity and improved service to customers. Workers may react with an increased stress response due to heightened work pace, more imminent deadlines, electronic performance monitoring and less control over task scheduling (Griffiths et al. 2007). Organisational workplace factors include high job demands, low job control, low supervisor support, effort reward imbalance and work style (Bongers et al. 2006).

A combination of high job demands and low job control, especially in combination with low social support, can lead to stress and therefore contribute to neck and upper limb MSS (Bongers et al. 2006). Bongers et al. (2006) found only one of these factors to be modestly related to symptoms of the neck and upper limb when reviewing several high quality studies, so it seems that high job demand and low job control are not strong contributors to WRNP. Eltayeb et al. (2011), in turn, found that perceived job demands, such as task difficulty and time pressure, were the strongest predictors for symptoms in the neck, shoulder and upper limb areas. Specifically for the neck area, Eltayeb et al. (2011) found perceived high social support to be a protective factor. This is further supported by Jensen (2003) who found that computer users reporting low co-worker support were more likely to develop neck pain.

Work style is a learned strategy utilised by the worker to respond to, cope with and complete job demands (Bernaards et al. 2007). A high-risk work style includes fewer or no work breaks, working despite pain, working at a high pace or long hours to produce high output, demanding high standards of one's own performances at work and applying excessive forces to the keyboard or mouse (Bongers et al. 2006; Griffiths et al. 2007). Individual differences in the responses to increased job demands may explain why some workers develop WRNP and others do not (Bernaards et al. 2007). Bernaards et al. (2007) studied work style intervention and concluded that their intervention on work style in computer users with WRNP was not only effective in reducing pain, but also changed some aspects of work style behaviour.

Recommendations to improve organisational workplace factors need to come primarily from the employer and include:

- realistic working hours;
- a realistic workload;
- deadline and performance monitoring expectations;
- allowing adequate rest breaks.

(Griffiths et al. 2007).

Organisational work factors may actually result in higher physical work-related factors. Higher job demands may result in longer working hours, fewer rest breaks,

fewer postural changes, less physical task variability or increased muscular forces as a consequence (Bongers et al. 2006; Griffiths et al. 2012).

1.3.3. Work-related physical factors

The ergonomics of a workstation can increase exposure to physical factors, such as awkward, non-neutral or static postures and higher muscle activity, thereby contributing to the development of musculoskeletal pain in certain body parts (Bruno Garza et al. 2012; Straker and Mekhora 2000). Janwantanakul et al. (2008) did a survey of office workers in Thailand and found that 63% of respondents attribute their MSS to physical work factors, with the most common affected anatomical area being the head and neck, followed by the lower back, and third most the upper back. In addition, 71% of the workers experiencing symptoms rated their workstation ergonomics as poor, as opposed to 59% of those without symptoms (Janwantanakul et al. 2008). These work related physical factors include duration of computer work, static awkward postures, monitor height, use of a document holder, desk height, keyboard and mouse use and seat height.

Duration of computer work

Ariëns et al.'s (2001) study found a significant positive association between prolonged sitting at work and neck pain. They found that workers who sat for more than 95% of the time had more than twice the risk of developing neck pain compared to workers who spent less time sitting down at the job. This study did not look specifically at computer users.

With regard to computer users, Cagnie et al. (2006) found neck pain to be significantly associated with computer working time, and Griffiths et al. (2012) found a linear relationship between hours worked with a computer per day and the prevalence of MSS in all areas including the neck, but not for the upper back. They concluded that risk for the upper extremity was particularly evident when working with a computer for more than 20 hours per week, irrespective of the occupational group or level of responsibility of the computer user (Griffiths et al. 2012). Weekly computer usage was found to be prognostic of neck pain in a study on South African high-school students (Smith et al. 2009) and Green (2008) found that in adolescents, using the computer more than four to five hours per day, was a risk factor for neck pain. Two further studies found an association between neck and shoulder pain and

long hours of computer work; in one study more than seven hours (Demure et al. 2000), and in the other eight and a half hours (Van den Heuvel et al. 2006) per day were found to be associated with WRNP. An association between duration of computer work in females and symptoms in the neck area has been determined (Blatter and Bongers 2002; Jensen et al. 2002). Both of these studies adjusted for physical and psychosocial factors and found that the physical factors, such as neck flexion, were more likely to be responsible for the results rather than the psychosocial issues (Blatter and Bongers 2002).

In contrast, Silanpaa et al. (2003) found no association between long duration of computer work and neck and shoulder symptoms.

Possibly it is not the time spent at the computer that is a risk factor, but the posture of the computer user. Working with the neck in a forward bent posture for a prolonged time seems to be associated with neck pain. Ariëns et al. (2001) found a positive association between neck pain and neck flexion, although not significant. The study by Ariëns was not occupation specific, therefore when investigating computer users it seems relevant to assess the relationship between neck posture and WRNP.

Static awkward posture

The Occupational Safety and Health Administration (OSHA) provides computer users with information on the “best” postures to assume to influence musculoskeletal comfort. The underlying theory behind this practice is that the discrepancies in workstation set-up are one aggravating factor in the development of work related MSS. Postures outside these recommended parameters are termed awkward postures and are thought to occur when the workstation configuration and the anthropometrics of the computer user are incongruent, allowing stress and strain on musculoskeletal structures and resulting in pain and discomfort (Baker and Moehling, 2013). Sharan et al. (2012) found a significant association between the Rapid Upper Limb Assessment Score (RULA), ergonomic workstation risk factors and musculoskeletal pain in Indian computer workers, most of whom were working more than eight hours per day. They found 30% of workers to be at action level two on the RULA scale, indicating that their workstations require adjustments soon. Fifteen percent were at an action level four, meaning that their postures require

change immediately. These non-neutral static postures can decrease the blood circulation to the muscles, reducing the supply of nutrients and removal of wastes, which can lead to muscle fatigue and pain (Mekhora et al. 2000). According to Da Costa and Vierra (2010) the National Institute for Occupational Health and Safety report stated that non-neutral, awkward postures often assumed when computing were risk factors for the development of work-related neck MSD.

Monitor height

The effect of the computer monitor height on WRNP will be discussed in separate sections. These sections are as follows: Head and neck posture, the visual system and muscle activity.

Head and neck posture seems to be an important component of the physical impact of computer set-up, as the head orientation tends to follow the eyes which are directed at the monitor. Thus placement of the monitor would seem to effect changes in head and neck posture, and may influence WRNP. Straker et al. (2008) reviewed the literature and found that previous studies report an overall relatively linear increase in head and neck flexion (relative to the vertical) as the visual target moves lower than eye height (negative gaze angles relative to the horizontal). Similarly, a few studies have shown a higher positioned monitor to result in a more upright and less flexed head and neck posture (Dainoff et al. 2005; Sommerich et al. 2001; Villanuevai et al. 1997).

Increasing the vertical height of the monitor above eye height may result in increased upper cervical muscle activity (Straker et al. 2008). Two studies were found indicating a higher risk for neck pain if the top of the monitor is positioned higher than the eye line. Jensen (2003) studied computer users and found an increased risk for neck pain in females who had the top of the monitor higher than eye level, possibly causing the neck to extend. This monitor position was not found to predict neck symptoms among men. Van den Heuvel et al. (2006) found neck extension to be statistically significantly associated with neck–shoulder symptoms.

Two prospective studies assessing office workers using self-report questionnaires found no significant relationship between risk of neck pain and monitor height (Brandt et al. 2004; Kiss et al. 2012). Kiss et al. (2012) found that placing the screen

at eye level was the most popular screen position for their respondents, and yet an insignificant lower percentage of these people had neck and shoulder complaints compared to respondents with self-reported too low or too high screen heights. However, it may not be accurate to investigate workplace design aspects with self-report questionnaires (Jensen 2003).

Finally, two studies were found that indicated a low monitor height to be beneficial. Marcus et al. (2002) found that increased head flexion was associated with a reduced risk of neck and shoulder symptoms and disorders in computer operators, but he used a single measurement of posture to represent each worker's exposure during computer use, resulting in weak evidence. Korhonen et al. (2003) found a higher risk of neck pain if the distance between the top of the screen and the eye line was less than 10 cm, but as their study participants had a mean age of 47 years and commonly wore bifocals a higher monitor height could have resulted in extension of the neck.

A dynamic relationship exists between the visual system, the musculoskeletal system and the head and neck posture (Fostervold et al. 2006), making the association between WRNP and monitor height complicated (Kiss et al. 2012). Computer workers with presbyopia wearing bifocals may find a higher monitor location to be associated with neck extension, while a low placement may offer the benefit of less visual strain, but can be associated with musculoskeletal stress caused by increased neck flexion (Korhonen et al. 2003).

Monitor height seems to have an effect on muscle activity with a low monitor position increasing neck flexion which may result in heightened forces in the articulations of the cervical spine and thus result in nociceptive input from tissues such as ligaments and joint capsules. In addition, increased continuous low threshold postural muscle activity of the neck extensors is needed to counter the neck flexion moment (Szeto et al. 2005) resulting in localised muscle fatigue, a contributor to the development of neck pain in computer workers (Psihogios et al. 2001). Increased neck muscle activity can result in an increased risk of developing a MSD (Brandt et al. 2004). A few studies found that low monitor height resulted in higher muscle activity levels of the cervical and thoracic erector spinae (Babski-Reeves et al. 2005; Sommerich et al. 2001; Straker et al. 2008; Straker and Mekhora 2000; Turville et al. 1998;

Villanuevai et al. 1997). Wahlstrom (2004) identified a relationship between activity of the trapezius muscle and musculoskeletal problems in the neck and shoulder region.

Two short duration task laboratory studies on pain free subjects found that placing the top of the monitor level with the eye line showed no statistically significant reduction in posterior muscle activity when compared to a low monitor setting (Kothiyal and Bjørnerem 2009; Straker et al. 2008). The subjects in Kothiyal and Bjørnerem's (2009) study did report increased comfort when the top of the monitor was aligned with the eyes. Straker (2008) did find that the posterior muscle activity did increase when the participants increased the amount of neck flexion even further for the purpose of reading from a book lying on the desk. This may suggest that there could be an increased risk of neck MSDs when working with documents that are on the desk, resulting in the computer user having to look down.

While recommendations can be made on "optimal" monitor heights, such as aligning the top of the monitor with eye height, there remain gaps and inconsistencies in the literature, and there seems to be no conclusive answer as to what constitutes the best posture (or range of postures) (Babski-Reeves et al. 2005). Kothiyal and Bjørnerem (2009) suggests that professionals advising computer users with WRNP should remain cautious, as the optimal monitor setting for an individual is determined firstly by a balance between musculoskeletal and visual strain, and secondly, is dependent on various workplace factors.

Document holder

Another physical risk factor for WRNP is working with paper. Increased head and neck flexion and the subsequent increased muscle activity could occur when the computer user is working with documents that are lying on the desk surface. Gerr et al. (2000) compared computer users using a document holder to those without, and concluded that the use of a document holder was associated with a significant reduced downward gaze angle, head tilt angle and head rotation angle. Findings of a study by Goostrey et al. (2014) suggest that a laterally positioned document holder at screen level could be a more appropriate location due to fewer excursions of the neck into flexion. This may hold true, and yet this would result in increased rotation

for the computer user to look at the document, and Van den Heuvel et al. (2006) have identified rotation as a risk factor in neck/shoulder symptoms.

Mouse, keyboard and desk height factors

Long hours spent using a mouse and keyboard increase the risk of having neck and shoulder disorders (Johnston et al. 2009), so investigating the placement of the keyboard and mouse seems beneficial when attempting to identify risk factors for WRNP. A too high working surface may result in elevated scapulae or abducted upper arms for the computer user to reach the keyboard or the mouse. Desk heights that are too low have been reported to predispose the computer worker to stoop, which may result in thoracic and/or neck pain due to the need to flex forward to interact with the desk surface (Milanese and Grimmer 2004).

Marcus et al. (2002) found that computer workers who had an inner elbow angle greater than 121° when keying were five times less likely to develop WRNP compared to those working with smaller elbow angles. This protective effect diminished with longer duration of keying, so is not necessarily beneficial for a computer worker who spends the entire day keying. It seems that the elbow should be in line with the desk or slightly higher (Marcus et al. 2002).

As the keyboard and the mouse are often used simultaneously on the desk, their location is inter-dependent. The design and size of the keyboard affects the location of the mouse, and the location of the mouse affects the arm, shoulder and upper back posture. In intensive mouse users, a keyboard without a number pad would allow the mouse to be positioned closer resulting in a more neutral arm position and less abduction or flexion of the upper arm. Kiss et al. (2012) found that the influence of reaching distance for the computer mouse is at least as important, if not more, than usage time. Therefore having the shoulder too abducted or too flexed as is required to reach the mouse that is too far away, is a risk factor for WRNP (Kiss et al. 2012).

A review by Waersted et al. (2010) concluded that time spent at a keyboard had no association with tension neck pain; whereas time spent using the mouse had limited evidence. Brandt et al. (2004), in turn, found that computer users that used the mouse for more than 25 hours per week had a four-fold risk of WRNP.

Conversely, a prospective study amongst office workers found that placement of the mouse was not found to be a significant risk factor, but incorrect positioning of the keyboard may predict neck pain (Korhonen et al. 2003). It seems that the keyboard should not be placed at the front edge of the desk. Marcus et al. (2002) found a small reduction in the incidence of neck/shoulder pain when the keyboard was placed more than seventeen centimetres away from the edge of the desk. Similarly, Brandt et al. (2004) found decreased neck pain in workers who had the keyboard more than fifteen centimetres away from the edge of the desk.

Computer users should make sure that the desk on which the mouse and the keyboard are placed is at, or slightly lower than, seated elbow height and the keyboard should not be situated at the front edge of the desk, rather slightly away, to allow the arms to rest.

Armrests

During keyboard and mouse work, there should also be enough support for the proximal forearm; otherwise the elbows may elevate resulting in increased muscle tension in the neck and shoulder region (Kiss et al. 2012). Kiss et al. (2012) found that arm supports on the chair and supporting at least two thirds of the forearm on the desk were significantly negatively associated with WRNP. Rempel et al. (2006) also found that if computer users support their forearms while working, this can result in reduced WRNP and can prevent the onset of neck and shoulder disorders, when compared to ergonomics training alone.

Brandt et al. (2004), however, found no association between using armrests and neck pain in computer users. A Cochrane review investigating ergonomic design and training for preventing work-related MSDs of the neck and upper limb concluded that there is moderate support for the use of arm support (Hoe et al. 2012). The evidence for armrests therefore remains inconclusive, despite the biomechanical plausibility. Hoeben and Louw (2014) also found that the adjustability of arm rests did not significantly affect reduction of pain intensity and frequency of WRNP in a single subject study comparing different quality office chairs.

Seat height

Ergonomics recommendations for seat height used by most studies are based on recommendations presented by Grandjean (1987) and Pheasant (1996) in Milanese and Grimmer (2004). These recommendations are as follows: The seat height should be adjustable given the range of anthropometric dimensions of the adult population. It should measure equal to or slightly less than the popliteal height of the sitter. If the seat height is greater than popliteal height the sitter may experience increased tissue pressure on the posterior aspect of the thighs. If the measured chair seat height is lower than the popliteal height of the sitter, the sitter may flex more than 90 degrees at the hip resulting in increased lumbar flexion (Milanese and Grimmer 2004). As the lumbar spine flexes, a change may occur in the thoracic spine which may result in a forward head on neck posture (Horton et al. 2010), thus affecting the neck.

This direct influence on body posture and the increased risk of WRNP with prolonged sitting at work, implies that the chair could contribute to WRNP. If desk height is adjustable, measuring chair height based on popliteal height as suggested above can be used. An adjustable desk is not always available or economically viable (Hochanadel 1995; van Niekerk et al. 2012) and it seems as if a seat height calculation found in a study by Hochanadel (1995) offers a more practical computation for seat height in order to ensure that elbow height is level or slightly higher than desk or keyboard height, as was found to be. As seated elbow height (the vertical distance from the seat to elbow when the worker sits with the arms relaxed at the side) should be equal to or slightly more than the vertical distance between the table and the seat; seat height should be calculated as being equal to desk/keyboard height minus seated elbow height. Once chair height has been established, the feet should be fully supported on the floor on a footrest.

Correct chair height may well contribute to the computer worker's subjective feeling of comfort of the sitting position. Lindegård et al.'s (2012) study found a low perceived comfort scoring of a chair contributed to the risk of developing neck symptoms. In addition, Kothiyal and Bjørnerem (2009) found that subjective measurements of comfort of the computer user are related to efficiency, productivity

and job satisfaction and that workers who feel uncomfortable, complain more, are more unhappy and more frequently absent from work.

Office environment, rest breaks, precision work

The physical office environment includes five features: size of the office, lighting, temperature, air quality and acoustics are also associated with WRNP. Korhonen et al. (2003) calculated the mean of these five components for each of his study participants and found the mean of the five components of the physical office environment to be a significant predictor for neck pain.

Rocha et al. (2005) showed that thermal comfort was a factor associated with neck/shoulder symptoms, although the paper does not explain what is meant by thermal comfort, it seems that a comfortable ambient temperature is implied.

Aarås et al. (2001) advocated the importance of improved luminance of the lighting conditions within an office environment to reduce visual discomfort in computer work. Lighting should be between 500 and 1000 lux, and contrast glare should be avoided by installing some indirect lighting in addition to direct lighting. The monitor should be two meters away from a window to avoid daylight brightness and glare. Aarås et al. (2001) found visual discomfort to correlate highly with neck pain.

Rocha et al. (2005) found a strong association between WRNP and lack of rest breaks. Similarly, Cagnie et al. (2007) found rest breaks to have a protective effect indicating that they may allow muscle relaxation as well as decreasing computer exposure. Wahlstrom (2004) found that precision work was a risk factor for developing neck and upper body MSS.

Summarising the physical workstation factors, recommendations include:

- avoiding long hours of computing, interspersing with other tasks;
- adequate rest breaks;
- seat height to be at or slightly higher than seated elbow height;
- top monitor to be in line with the eyes, or lower if the computer user uses gradient lenses;
- using a document holder if possible;

- keeping mouse and keyboard close to each other and away from the front edge of desk to enable arms to rest, or use of;
- using a chair arm rest;
- thermal comfort;
- lighting to be sufficient, with some indirect lighting;
- workstation not too close to windows to reduce glare.

The Neck Pain Task Force 2000-2010 concluded that it is unlikely that any single risk factor is responsible for the development of WRNP, but that it is more likely that several risk factors combined contribute to produce WRNP (Cote et al. 2008). Interventions aimed at reducing WRNP should therefore be multifactorial in design, and not only identify and deal with the physical workstation and individual risk factors, but also ensure the active involvement and support of the organisation.

1.4. Interventions for WRNP in Computer Workers

WRNP is a major health issue in the working population with office and computer workers having the highest incidence (Cote et al. 2008). The consequences for the worker in terms of pain, possible disability and loss of income, as well as for the employer in terms of absenteeism and presenteeism, and for society as a whole in terms of economic costs (Aas et al. 2011) make prevention essential. Primary prevention seeks to stop the asymptomatic worker from developing symptoms, secondary prevention is addressed at symptomatic workers, while tertiary prevention is aimed at workers who are sick listed and helps them return to work (Driessen et al. 2010).

The International Ergonomics Association describes ergonomics as the science dealing with various anatomical, physiological, psychological and engineering philosophies and their interaction with people. In other words, ergonomics is the science of "fitting the task to the worker" (Khan et al. 2012). Ergonomics should therefore focus on addressing a combination of these factors.

Various ergonomic workplace interventions, such as equipment, postural education, varying work tasks and adjusting work style of the computer user, and the overall office environment have been implemented to address the risk factors for WRNP.

In the following section the effect of multifactorial interventions as well as monitor and chair height interventions will be discussed. The multifactorial interventions are depicted in Table 1.2.

1.4.1. Multi factorial interventions

Table 1.2: Multi-factorial interventions

Author	Population	Intervention	Effect on WRNP
Mekhora et al. 2000	470 computer users with tension neck syndrome.	Ergonomic workstation adjustment including monitor height, two groups with delayed intervention.	Significant decrease in discomfort in all areas including the neck and upper back.
Ketola et al. 2002	124 office workers using computers.	Ergonomic workstation adjustment vs ergonomic training vs control.	Better ergonomic workstation rating, less discomfort and less strain mostly in the shoulder, upper arm, neck and upper back area occurred in the ergonomic adjustment plus training group. No statistical difference between groups.
Amick et al. 2003	168 office workers using computer at least four hours of the day.	Office ergonomics training plus workstation adjustment vs ergonomics training only vs control.	Composite score of nine body parts, including neck, upper back and shoulders. Reduction in average pain levels over the workday mostly for training plus workstation adjustment, but also for training only group compared to control. Both intervention groups had better work postures and reported higher perceived control over their workspace and greater overall ergonomic knowledge than workers in the control group.
Pillastrini et al. 2007	200 office workers using the computer for at least 20 hours per week.	Informative ergonomic brochure compared to brochure plus ergonomic workstation adjustment.	Workstation adjustment plus brochure group had better work related posture and decreased lower back, neck and shoulders MSDs compared to brochure only.

Robertson et al. 2009	216 Computer workers with an average of 5-6 hours of computing per day.	Ergonomic training vs ergonomic training plus highly adjustable chair vs control.	Both groups had less awkward non-neutral postures measured by RULA scores.
Hedge et al. 2011	1504 office workers, 89% worked more than four hours per day at the computer. Neck most common symptomatic area.	One hour ergonomic training followed by an ergonomic workstation adjustment and self-report questionnaire. Follow up self-report questionnaire 60 days later. No control.	Decrease in MSD in all body areas with neck, upper back and shoulders showing statistical significance.
Mirmohammadi et al. 2012	70 computer users using the computer at least four hours a day.	Four hour ergonomic training programme, no control.	Improvement in work postures for all body parts and improved arrangement of workstation components.
Esmailzadeh et al. 2014	69 symptomatic computer users	Ergonomic training plus brochure plus workstation adjustment vs control	Statistically significant decrease in MSS in neck and upper back in intervention group compared to control.

In multi-factorial interventions, it is impossible to identify the aspect of the intervention that resulted in an outcome. If looking towards systematic reviews for an answer, the outcomes regarding specific intervention success remains elusive. Table 1.3 depicts a summary of systematic reviews of ergonomic interventions in the workplace. The conclusions regarding the effectiveness of specific interventions are divergent. The conflicting evidence is likely to be as a result of methodological differences used in the reviews and the lack of high quality homogenous studies found in the literature. Therefore, the effectiveness of specific ergonomic interventions for the management of neck and upper back disorders remains unclear.

Table 1.3: Systematic reviews on ergonomic interventions

Literature Review	Aim of Study	Population	Results for Neck Pain /Comfort
Brewer et al. (2006)	Effect of workplace interventions on visual and upper body MSSs or MSDs.	Computer users	Moderate evidence of no effect for rest breaks.
Boocock et al. (2007)	Interventions for neck/upper extremity musculoskeletal conditions.	Computer users	Evidence supporting work environment/ workstation adjustments for computer users with neck and upper extremity symptoms.
Kennedy et al. (2010)	Interventions to prevent upper extremity MSDs and MSSs.	Workers	Moderate evidence for arm supports and limited evidence for ergonomics training plus workstation adjustments, new chairs, and rest breaks on upper-extremity MSD outcomes.
Driessen et al. (2010)	Effectiveness of ergonomic interventions for low back pain and neck pain.	Workers	Low to moderate quality evidence that physical and organisational ergonomic interventions were not more effective on acute and chronic neck pain intensity than no intervention.
Aas et al. (2011)	Effectiveness of workplace interventions for workers with neck pain.	Workers	Insufficient evidence for workplace interventions to show significant differences for neck pain.

1.4.2. Monitor height interventions

In the ergonomic literature regarding computer monitor height, a common recommendation is to place the monitor directly in front of the user, and the top of the screen at eye level (Psihogios et al. 2001). A few laboratory studies were found supporting this.

Koyithal and Bjørnerem (2009) did a study involving a ten minute typing task and found a statistically significant higher comfort rating with a high monitor setting (line of sight fifteen degrees below the horizontal) compared to two lower monitor settings. Straker et al. (1997) expected a change in discomfort based on the more flexed neck posture assumed by laptop users compared to desktop computer users. They reported a strong trend towards higher discomfort in the laptop users, but this was not statistically significant. Similarly, Straker and Mekhora (2000) found no significant difference in self-reported discomfort of the head and the neck comparing a high and a low monitor setting, although there was again a trend towards greater discomfort for the low monitor position. In conclusion, it seems that the above laboratory studies show a trend towards lower discomfort in the neck with a placement of the top of the monitor in line with the eyes.

1.4.3. Seat height interventions

The research into ergonomic chairs is scant, which is surprising considering how frequently they are recommended. In addition, it seems that chairs are often not ergonomically correct, as was found in a study performed at schools in the Western Cape. The chairs in the computer laboratories were found to be the least ergonomic part of the scholars' workstations (Smith et al. 2009).

Gerr et al. (2000) reported that adjustability of workstation chairs did not change neck or upper limb postures. Although not specifically evaluating the effect on neck and upper back pain, a literature review investigating the effectiveness of chair interventions by van Niekerk et al. (2012) did find a consistent trend of support for a chair intervention improving musculoskeletal symptoms among seated workers.

Hoeben and Louw (2014) investigated a chair intervention using an expensive fully adjustable ergonomically designed chair and a conventional office chair, and found that both chairs reduced the intensity, frequency and variability of WRNP in the two

participants who were blinded as to which chair they were given. This study concluded that as long as the computer user has an adjustable chair, seat height should be matched to the worker's anthropometry.

1.5. Conclusion

From this literature review it seems that numerous risk factors predisposing computer users to WRNP have been identified. Intervention studies have therefore been mostly multifactorial, and are as yet unable to confidently ascertain the effect of specific workstation adjustments on WRNP in computer users. Furthermore, it seems that there is some evidence that monitor height and seat height adjustments can improve comfort and WRNP in computer users. As professionals we need to answer questions from workers and employers, so that we may justify why specific ergonomic interventions should be implemented. It thus becomes important to continue researching which components of the computer workstation arrangement contribute to the wellbeing of the computer user.

Chapter2: Journal Article

2.1. Abstract

Background: The use of computers at school, university, work and for social media is growing and whilst neck pain is common in the general population, computer users have an even higher prevalence. Incorrect workstation ergonomics have been identified as a risk factor for the development of neck pain in computer workers.

Aims: To assess the effect of adjusting chair and monitor height of a female office worker's computer workstation on work related neck and upper back pain intensity, comfort of her sitting posture and disability.

Methods: An N=1 study was conducted using the A-B-C design consisting of a computer workstation adjustment involving chair and monitor height of a female office worker. The effect of the intervention was evaluated using the Visual Analogue Scale (VAS) to measure neck and upper back pain intensity and comfort of sitting position, and the Neck Disability Index to measure disability. The effect of the intervention was assessed over the three phases, consisting of four weeks each. During these phases, the participant could continue with her usual computer work. The results were compiled and tabulated.

Results: A reduction in neck and upper back pain intensity as well as an increase in sitting comfort position were found. However these improvements were not statistically or clinically significant. The effect size for pain intensity was 0.76 and for sitting comfort 0.21. The participant reported no disability as measured by the Neck Disability Index, at the start and at the end at the end of the study.

Conclusion: The vertical adjustment of this female office worker's chair and monitor height according to her anthropometrics improved neck and upper back pain intensity and comfort of sitting position. This ergonomic workstation intervention could form part of a practical management option for computer users with neck and upper back pain. Further research is recommended to establish whether these findings are generalizable to the wider community of computer users.

2.2. Introduction

Musculoskeletal disorders (MSDs) of the neck and shoulder region are common among computer users (Cagnie et al. 2007; Cote et al. 2008; Wærsted et al. 2010). MSDs affect the worker, suffering neck pain and possible functional limitation, as well as the employer who is affected by loss of productivity (van den Heuvel et al. 2007) or absenteeism (Kiss et al. 2012). Green (2008) also reports that chronic neck pain patients use the health care system twice as often as the rest of the population, leading to financial and public health implications.

Most work-related neck pain (WRNP) is non-traumatic (Cote et al. 2008) and the aetiology is multifactorial, encompassing a complex interaction among individual, work organisational, psychosocial and physical (ergonomic) factors (Bongers et al. 2006; Cote et al. 2008). Female gender, previous symptoms, age, lack of physical exercise and high body mass index have been identified as being individual risk factors (Cagnie et al. 2007; Korhonen et al. 2003; Paksaichol et al. 2012). Ergonomic risk factors include poor workstation ergonomics (Esmaeilzadeh et al. 2014; Kothiyal and Børnerem 2009; Mekhora et al. 2000; van Niekerk et al. 2012), working with the head and neck in flexion (Ariëns et al. 2001; Marcus et al. 2002), hours spent in sedentary work positions (Ariëns et al. 2001; Brandt et al. 2004; Jensen 2003; Smith et al. 2009), awkward postures (Baker and Moehling 2013; Sharan et al. 2012), lighting and temperature of the room (Korhonen et al. 2003), repetitive and precision work (Wahlstrom 2005) and lack of rest breaks (Van den Heuvel et al. 2006). Psychosocial risk factors comprise high work load and low job control (Cote et al. 2008; Paksaichol et al. 2012; Rempel et al. 2006). Rating the physical work environment as poor increased the risk for neck pain twofold (Korhonen et al. 2003).

Wærsted et al. (2010) hypothesised that all occupations have psychosocial and organisational factors in common, thus the computer workstation layout and individual working technique may have an influence on the load placed on the neck resulting in WRNP. Physical workstation risk factors include small elbow angles (Marcus et al. 2002), mouse use in females (Sillanpaa et al. 2003), poor placement of the keyboard (Korhonen et al. 2003; Marcus et al. 2002) and chairs that do not have arm rests/forearm support (Marcus et al. 2002; Rempel et al. 2006; Wærsted et

al. 2010). In addition, using document holders, correct monitor placing and adjustable chairs may reduce neck load (Cagnie et al. 2007).

Numerous studies have investigated the simultaneous implementation of multiple ergonomic workstation interventions (Amick III et al. 2003; Brisson et al. 1999; Dainoff et al 2005; Nelson and Silverstein, 1998). Even if such studies conclude that ergonomic interventions reduce WRNP, it remains difficult to link the benefit to a particular component of the intervention. It thus seems worthwhile to ascertain whether it is possible to change a specific component of the computer workstation arrangement that is a possible risk factor contributing towards WRNP, and assessing its effect.

Therefore the aim of this study is to establish the effect that a simple intervention in the form of monitor and chair height adjustment has on neck and upper back pain and comfort of the sitting position as well as perceived disability in a computer user. It was hypothesised that adjusting the vertical parameters of the workstation to fit the anthropometrics of the computer user could improve the worker's head and neck posture, reduce creep and strain on tissues and therefore decrease pain intensity, improve comfort of sitting posture and decrease perceived disability.

2.3. Methodology

2.3.1. Study design

An experimental N=1, A-B-C design study was conducted from May until September 2014 at the offices of an accounting firm in Hout Bay. The baseline phase, phase A, had the participant perform her working duties with her workstation unadjusted for four weeks. The intervention phase, phase B, consisted of adjusting seat and monitor height according to the participant's anthropometrics. The participant continued her daily office work for a further period of four weeks. During phase C, the withdrawal phase, the intervention was ceased and the participant could readjust the workstation to a preferential setting and a final four weeks of measurements were obtained.

The study was approved by the Health Research Ethics Committee at Stellenbosch University (S13/10/215) (Appendix 2), and the participant signed informed consent to participate (Appendix 3). Confidentiality was assured and the participant had the right to withdraw from the study at any time. Permission for the use of photographs was obtained.

2.3.2. Eligibility criteria and participant recruitment

The principle investigator collaborated with the owner of an accounting firm to send an email to all employees inviting them to participate in this study. Employees were eligible to participate if they were seated office workers aged between 18 and 65 years who spent more than five hours per day at the computer and complained of WRNP of at least three months duration. Further eligibility criteria included using a height adjustable chair and computer monitor which were not at the height deemed correct by the PC-Safe guidelines as described by Hochanadel (1995), and proficiency in English to be able to read and understand the questionnaires. Subjects were excluded if they had existing neurological impairment, pathology of the cervical or thoracic spines, previous surgery or trauma to the area, or were planning to have treatment in the timeline of the study. Further exclusion criteria were a body mass index score greater than 30 (Doll et al. 2000), pregnancy planned for the time of data collection (Borg-Stein et al 2005) and habitual smokers (McBeth and Jones 2007). Subjects wearing bifocals or varifocals were also excluded from the study, as the monitor placement suggested by the PC-Safe guidelines (Hochanadel 1995) could result in neck extension due to visual demands when using non single focus glasses (Burgess-Limerick et al. 1999).

2.3.3. Screening

All agreeable employees were sent the Screening Questionnaire (Appendix 4) to ascertain eligibility. One respondent was potentially eligible to participate and her workstation was measured to determine an anthropometric mismatch. A subjective and physical examination was subsequently performed by the principle researcher using the Entry Questionnaire (Appendix 7) to acquire demographic information, exclude pain of non-musculoskeletal aetiology, identify co-morbidities and the participant's recreational and sporting interests. The STarT (screening tool to alert doctors to the right treatment) psychosocial subscale was included to identify

psychosocial concerns. The STarT has a Chronbach's α value of 0.74 and its test-retest reliability has been demonstrated in lower back pain (Hill et al. 2008). No study was found to use this tool specifically for neck pain.

2.3.4. Outcome measures

Three primary outcome measures were used to determine the effect of the intervention, namely the Visual Analogue Scale (VAS) for pain intensity, the VAS for comfort of working posture and the Neck Disability Index (NDI) for disability.

The VAS for pain intensity

The VAS is a valid and reliable self-report instrument consisting of a 100 mm horizontal line labelled "no pain" at the left end, and "worst possible pain" at the right end. The participant rated the level of pain experienced over the previous two working days by drawing a cross on the VAS line. The pain VAS is simple to understand and easy to administer and score (Katz and Melzack, 1999). It has a good test-retest reliability ($r = 0.94$) and the MCID for other chronic pain conditions such as rheumatoid arthritis and rotator cuff disease is 11 and 13.7 points out of 100 respectively (Hawker et al. 2011). Esmailzadeh et al. (2014) similarly used a VAS to measure the intensity of work-related upper extremity symptoms in computer workers.

Comfort of sitting position

There is no gold standard for the measurement of comfort. Pearson (2009) stated that due to the absence of validated scales numerous authors have used the VAS, commonly used to assess pain, to measure comfort, using a different question and altered end point descriptors. Other studies on office workers have used the VAS to assess comfort/discomfort of the sitting position (Aarås et al. 2001; Gadge and Innes 2007; Mclean et al. 2001; Mekhora et al. 2000; Straker et al. 1997). A 100 mm horizontal line was used and it was anchored by the descriptors "very comfortable" at 0, and "extremely uncomfortable" at 10. Administration and scoring was performed as for the VAS pain.

Disability

Self-reported disability was measured using the NDI (Appendix 6) at the beginning of phase A and at the end of phase C. The NDI is the most widely used, and a strongly validated, instrument for assessing self-rated disability in patients with mechanical neck pain. It consists of ten items addressing functional activities, each scored out of five, with a total score out of 50. Test-retest correlations range from 0.90 and 0.93 and the internal consistency has been reported as Cronbach α values ranging from 0.74 to 0.93 (Vernon 2008). The NDI has been shown to be valid, reliable and sensitive to change, with a MCID of 3.5 out of 50 points (Pool et al. 2007; Vernon 2008).

2.3.5. Study procedure

The study procedure indicating scheduled outcome measures is outlined in Figure 2.1.

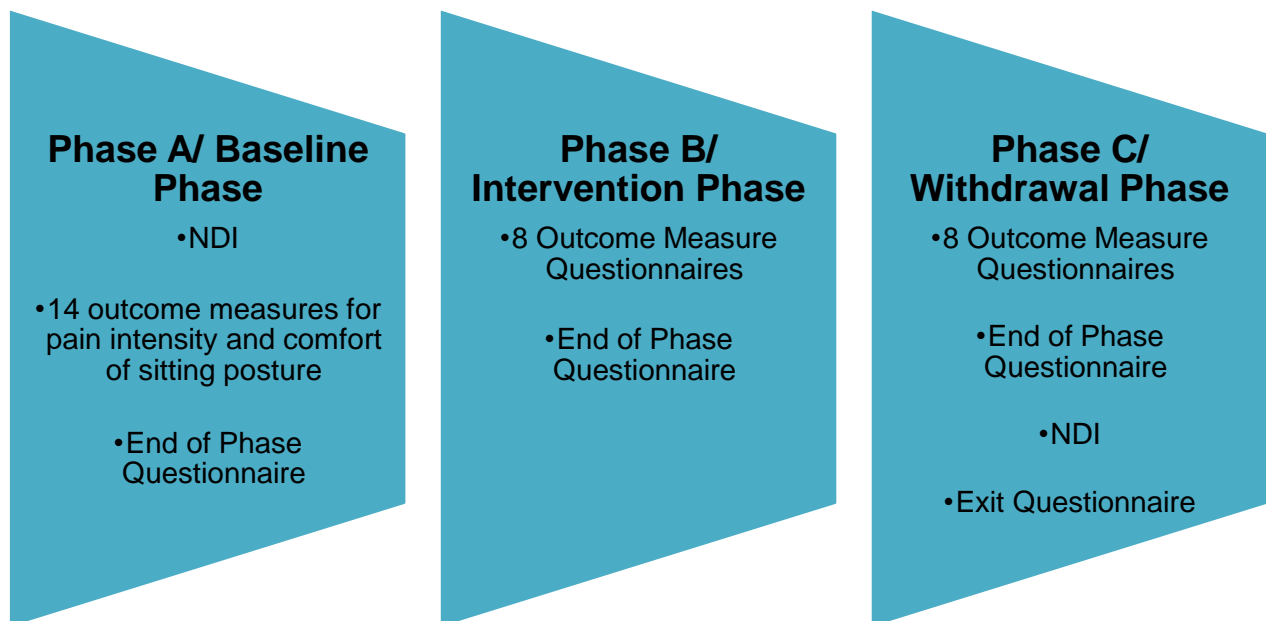


Figure 2.1: The study procedure outline

Phase A

The participant completed the NDI once at the start of the phase. The participant's baseline levels of pain intensity and comfort of sitting position were measured twice

a week, scheduled for 16h00 on a Tuesday and a Thursday. The principle investigator sent a reminder email ensuring compliance to complete the Outcome Measures Questionnaire (Appendix 8). The participant had to mark the average level of pain intensity and comfort of her sitting position as perceived over the previous two working days on the respective VASs. Once completed and folded, the questionnaire was placed in a sealed box supplied by the principal researcher and left at the participant's workplace, ensuring that questionnaires were not filled in using previous ones as a guide. Numerous public holidays and the odd day of study leave before an examination interrupted the outcome measure intervals. The baseline four week period was therefore extended by a further three weeks. Fourteen VAS baseline values for the two outcomes were obtained for phase A. The End of Phase Questionnaire (Appendix 9) established whether any confounding factors such as absenteeism, treatment, adjustments to the workstation or any other factors could have influenced the data.

Phase B

On the first day of phase B the participant's seat and monitor height were adjusted according to the PC-Safe guidelines (Hochanadel 1995) (Appendix 5). Eight outcome measures were obtained over the next four weeks. The aim of phase B was to establish any effect of the workstation adjustment on the participant's pain intensity and comfort of sitting position. The participant was asked not to change the workstation unless adverse effects were experienced. The participant completed the End of Phase Questionnaire at the end of phase B.

Phase C

At the start off phase C, the principal researcher informed the participant that the intervention had ceased, and that the participant was allowed to adjust her workstation as deemed suitable by her. The aim of phase C was to establish whether the participant would change the workstation and how this would affect the outcomes. Again eight outcome measurements were obtained. The End of Phase Questionnaire, a follow up NDI and an Exit Questionnaire (Appendix 10) were completed at the end of this phase, which also marked the end of the data collection for this study. The two NDI scores were calculated, by adding up the score of each of the ten sections for a maximum total score of 50 (Vernon 2008). The Exit

Questionnaire served to establish any confounding factors at work or within the family, or whether the participant's lifestyle could have affected the outcomes over the entire study period.

The sealed box was collected and the principle investigator measured the distance in millimetres from the low end of the VAS to the patient's mark to obtain a numerical index of the pain intensity and comfort of sitting position. The data were entered on a Microsoft Excel 2010 spreadsheet.

2.3.6. Data analysis

The data were entered into Microsoft Excel for analysis. Descriptive statistics and visual analysis were used to determine intra-subject variability and to summarise the data. Graphs were constructed to illustrate the pain intensity and comfort of sitting position measurements and their means for the three phases. The 2-SD band was calculated as the mean of the baseline phase (A) \pm the SD \times 2. A statistically significant change in performance was indicated if two consecutive points fell outside the 2-SD band (Ottenbacher et al. 1988). The effect size to determine the strength of the intervention (Beeson and Robey 2006) was calculated as the difference between the mean of the withdrawal phase (C) and the mean of the baseline phase (A) divided by the standard deviation (SD) of the baseline phase (A). Beeson and Robey (2006) proposed the following benchmarks for the interpretation of data: 0-2.6 corresponding to a small effect size; 2.7-3.9 being interpreted as a moderate effect; and 4-5.8 corresponding to large effect sizes. The variability of each phase was analysed to conclude on the stability of the outcomes measured. The End of Phase Questionnaires (Appendix 9) and the Exit Questionnaire (Appendix 10) were visually analysed to establish possible confounders to the results. Finally, a brief exit interview assessed the participant's satisfaction with the workstation adjustment.

2.4. Results

All seven employees of the accounting firm agreed to take part in this research, but only five experienced WRNP. Two were excluded due to previous whiplash trauma, one was planning to go on leave during the study period, and another wore bifocals. The workstation of the one remaining employee had an anthropometric mismatch and she agreed to take part in the study.

2.4.1. Participant description

The participant was employed as an accounting clerk since 2004. Her work involved high volumes of data capturing for at least eight hours per day with half an hour for lunch and two to three further short breaks per day. In addition she was studying part-time, but did most of the studying at her office computer during her workday. Her main complaint was pain in her left upper trapezius area (A1). Table 2.1 depicts a description of the participant and the behaviour of her pain A1, while Table 2.2 depicts relevant physical examination findings. No red or yellow flags were noted. She was not concerned about her pain, attributing her symptoms to her work posture and the stress related to her studies. The physical examination confirmed a cervical musculoskeletal origin to her pain. Both the active and passive cervical movements reproduced symptoms in area A1 and the left upper trapezius had increased tone on palpation. No adverse neural dynamics were noted. As can be seen in Figure 2.2 her workstation set up requires her to work from documentation lying to the left of her keyboard. Table 2.1 depicts the workstation measurements, which revealed that her chair was 14 mm too high, and the monitor 120 mm too low when considering the PC-Safe guidelines. The chair height difference was deemed minimal and was left unchanged for the intervention as her habitual chair height afforded adequate popliteal height, allowed the feet to be supported on the ground and permitted an elbow angle of slightly more than 90°.

Table 2.1: Workstation measurements and adjustments

Workstation parameters	Pre Intervention workstation measurements (mm) as in <i>Phase A</i> .	Adjusted workstation measurements as per the PC-Safe calculation (mm)	Difference (mm)
Seat height	513	499	14
Monitor height	1086	1206	120

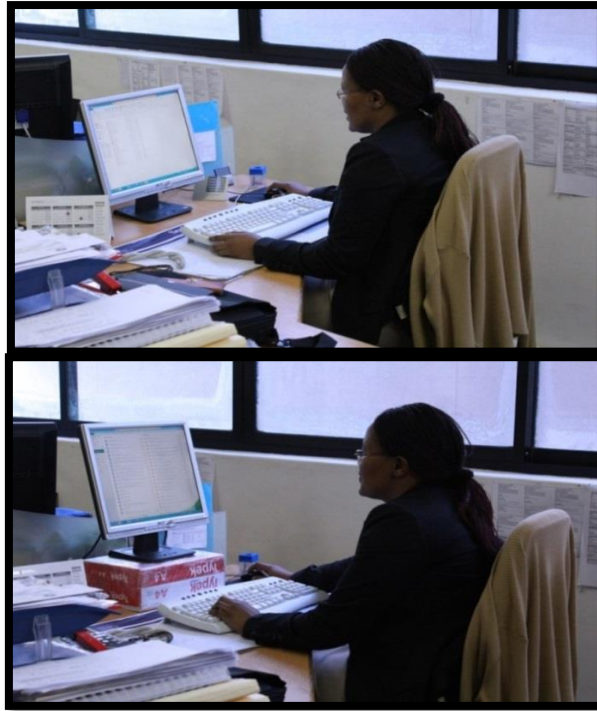


Figure 2.2: Photographs of participant's habitual (top) and adjusted (bottom) workstation

Table 2.2: Summary of the subjective examination

Participant description	Neck and upper back symptom description	Past Medical and Surgical History	History	24 hour behaviour	Aggravating factors	Easing factors
<p>35 year old female clerk in an accounting firm.</p> <p>Studying part time.</p> <p>No sport participation, no hobbies.</p> <p>Single, lives with child and sisters in stress free home situation.</p>	<p>Area: A1 in the left upper trapezius area.</p> <p>Intermittent.</p> <p>Quality: dull, feels like a “muscle spasm”</p> <p>Severity: 5/10 on a VAS.</p> <p>Depth: superficial.</p>	<p>Occasional migraines from age 16 until 2004.</p> <p>General health good.</p> <p>No chronic medication.</p> <p>Does get headaches, takes painkillers 3 x / week.</p>	<p>No history of upper quadrant injury or disease.</p> <p>A1 insidious onset, episodic since 2010, onset not related to commencement of present job or part time studies.</p>	<p>No night pain.</p> <p>A1 is 0/10 on waking.</p> <p>A1 starts after working for 2-3 hours.</p> <p>Feels the need to rest after work.</p> <p>Less pain on weekends.</p>	<p>Sitting and working at the computer at work.</p> <p>Stress from examinations.</p>	<p>Cooling Gel.</p> <p>Massage or rub.</p> <p>Resting after work.</p>

Table 2.3: Summary of the objective examination

Active range of movement	Thoracic spine and left glenohumeral joint	Muscle tone	Palpation	ULNDT
Flexion, extension, right rotation and right side flexion full range and pain free on overpressure. Rotation and Side flexion to the left full range with 4/10 and 5/10 respectively on a pain VAS in area A1.	All thoracic movements full range and did not elicit A1 on overpressure. Left glenohumeral joint special tests full range and pain free on overpressure.	Increased tone on palpation of the left upper trapezius.	Left unilateral postero-anterior Grade III+ Maitland pressures on C5/6 hypo mobile, 4/10 pain on a VAS for A1.	Median nerve tension test 1 elicited a pulling feeling in the left cubital fossa at -10° Elbow Extension, Left arm same as Right.

2.4.2. Visual Analogue Scales for pain intensity and comfort of sitting

VAS for pain intensity

Figure 2.3 depicts a graphical representation of the pain intensity as experienced by the participant and the mean pain intensity of each phase. Visual analysis showed a trend of improvement in pain. This improvement was not statistically significant, as none of the data points fell outside the 2SD bands. The two 2SD values were 33.7 and -7.98, rendering the 2SD band inappropriate as the lower value is a negative, which is not possible for a VAS as its lowest value is 0. The mean and variance of phases A, B and C is summarised in Table 2.4. The difference between the mean of phase C and phase A was 7.98 mm and is less than the MCID found for some chronic pain conditions, rendering the change not clinically important. The effect size computed was -0.76 indicating a small improvement in pain intensity.

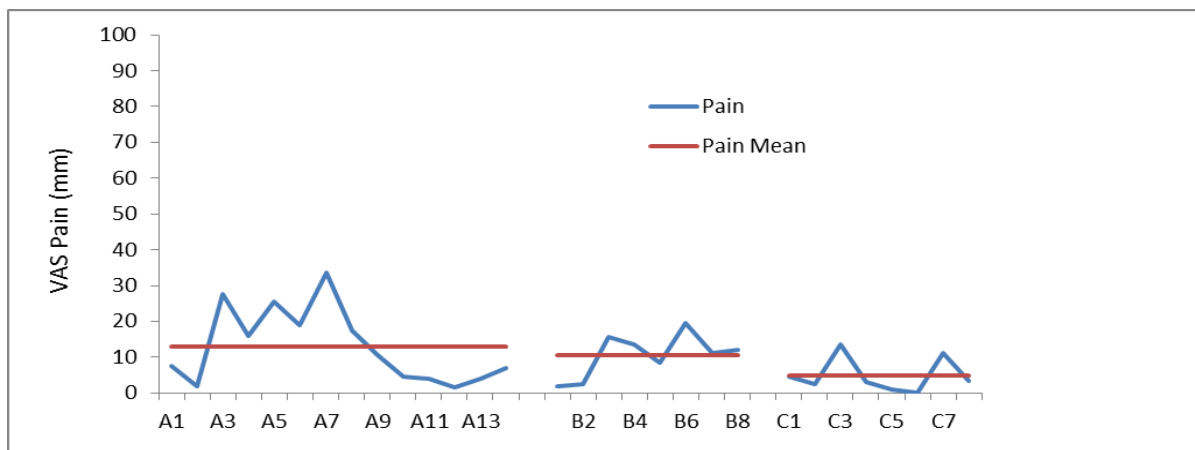


Figure 2.3: VAS pain and means for phases A, B and C

During the first four weeks of the baseline phase, there are peaks of pain scores which coincided with public holidays in South Africa, but also with the examinations period of the participant's part-time studies. Pain intensity decreased in the latter part of phase A. During phase B there was a slight but not significant decrease in the pain intensity. The participant did not change her workstation parameters during phase C, however, a further decrease in pain intensity was measured. It was noted that the variance of the pain intensity VAS scores decreased with subsequent phases indicating that the participants' symptoms became more consistent with

fewer intense pain episodes, even if the reduction in mean pain was not clinically important (Figure 2.3). She took no medication for her pain throughout the study.

Table 2.4: Table displaying means and variances of VAS pain and VAS comfort

	Phase A Mean (Min-Max) (mm)	Phase B Mean (Min-Max) (mm)	Phase C Mean (Min-Max) (mm)
VAS Pain intensity	12.86(2-33.5)	10.56(2-19.5)	4.88(0-13.5)
VAS Comfort of sitting posture	16(1-35.5)	16.81(2.5-38.5)	13.25(1.5-40)

VAS for comfort of sitting posture

Figure 2.4 depicts a graphical representation of comfort of sitting position measured by the VAS. The means and variance for phases A, B and C are summarised in Table 2.4. The 2SD band method of analysis was once again deemed inappropriate as the +2SD was 42.4 and the lower band -10.4 (which again is an impossible value for a VAS). There was a slight, insignificant change in the comfort level. The participant felt slightly less comfortable during phase B, but slightly more comfortable in phase C when compared to baseline phase A. As was for VAS pain, it can be noted that VAS comfort had high peaks during the first part of the baseline phase, coinciding with public holidays and the study period of the participant. The odd high peak during phases B and C caused the variance of the VAS comfort scores to increase over subsequent phases (Figure 2.4). The effect size was calculated and a value of -0.21 indicated a small improvement in comfort of sitting position.

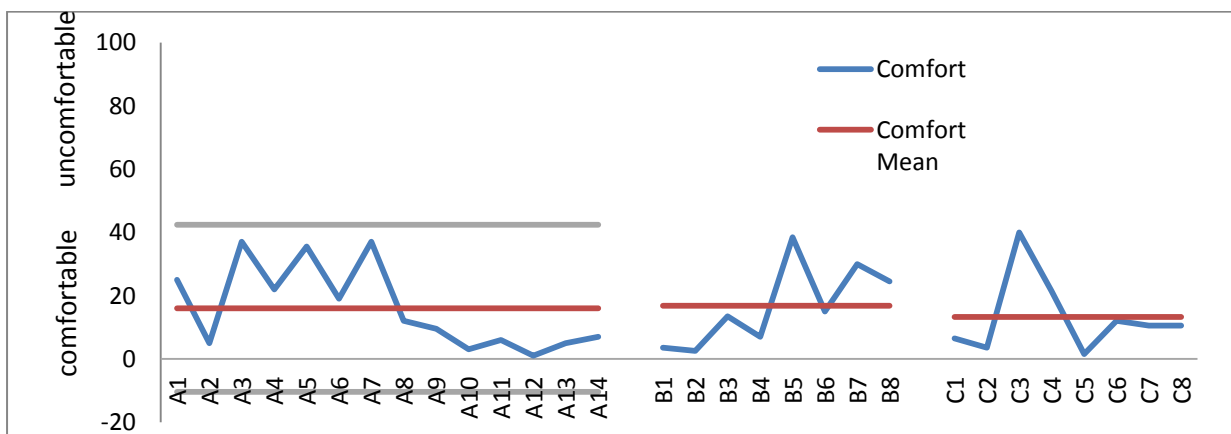


Figure 2.4: VAS comfort and means for phases A, B and C

Relationship between pain and comfort ratings

Figure 2.5 shows that there was a relationship between the two primary outcomes measured. Especially in phase A the peaks and troughs of the two outcomes occur concurrently. This is less evident in phases B and C.

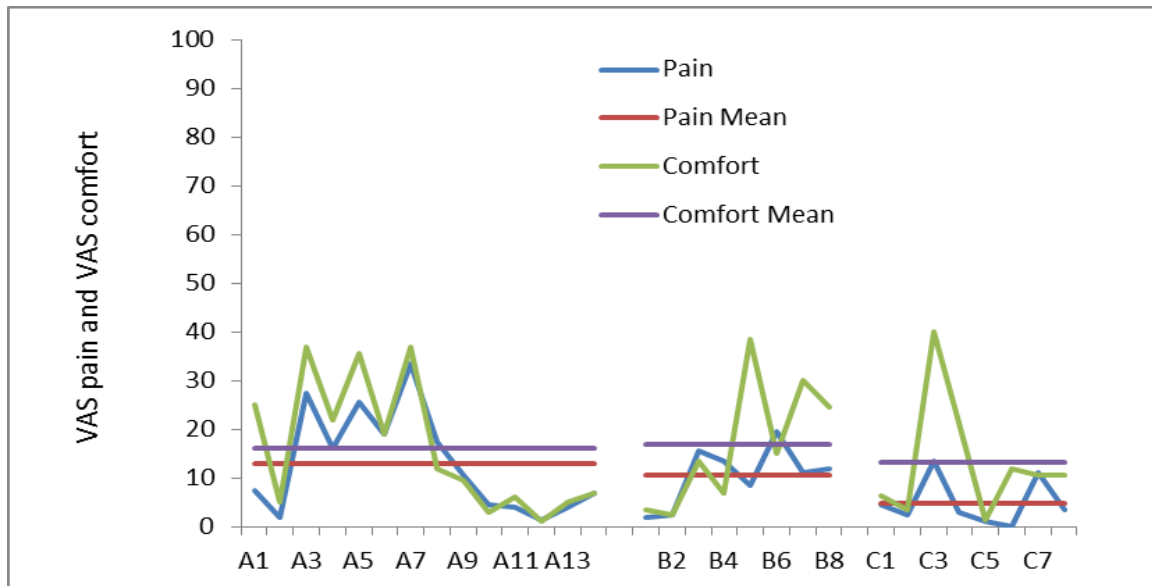


Figure 2.5: Graph of VAS pain, VAS comfort and means for phases A, B and C

2.4.3. Neck Disability Index

The participant scored 4/50 on the NDI Questionnaire both at the beginning of phase A and at the end of phase C although different items were marked on each occasion. The participant therefore never perceived herself as being disabled by her pain, as the scoring interpretation for the NDI regards a score of 0-4/50 to represent no disability. (Vernon 2008).

2.4.4. Analysis of the end of phase and exit questionnaires

Table 2.5 represents the data from the End of Phase Questionnaires. Despite taking some days off work for studying, the participant always allowed two working days to precede filling in an Outcomes Questionnaire. The Exit Questionnaire at the end of the study revealed that no changes in the nature of her work, the physical work environment, her level of physical activity, her general health or her family and social situations occurred for the duration of the study. She had no accidents or injuries to

her neck and upper back and did not change the prescription of her glasses. She did coincidentally change to a lower pillow for her sleeping position during phase B.

Table 2.5: Summary of data from the End of Phase and Exit Questionnaires

	Phase A	Phase B	Phase C
Absenteeism from work	Yes, one to two days study leave before each exam	None	Yes, 3 days unplanned leave. Travelled to the Eastern Cape
Treatment received	None	None	None
Adjustments to the workstation made by the participant	Not applicable	None	None
Anything that may have influenced A1	Nothing noted	change to a lower pillow	Nothing noted

A brief Exit Interview was held to ascertain the participant's satisfaction with the workstation adjustment. She reported being 80% satisfied with the workstation adjustment and reported to having adjusted the workstation of two colleagues in a similar manner. The participant deemed her workload to have been the same throughout the study period despite examinations in the first half of phase A and work-related periods of stress due to financial year end during phase B and C.

2.5. Discussion

To our knowledge this is the first study to report on the effect of adjusting the vertical parameters of the workstation of a computer user, without confounding postural advice, on pain intensity and comfort of sitting whilst working. Our findings illustrated that vertical adjustment of the seat and monitor height according to the participant's anthropometrics led to a clinical and statistically insignificant reduction in the participant's self-reported pain intensity and improvement of the comfort of sitting. The variance of pain intensity decreased from phase A to C of the study, whilst the comfort of sitting variance increased.

The female participant in the current study had several risk factors that might have predisposed her to develop WRNP. She had a history of neck pain on entering the

study. The Entry Questionnaire further established that the participant did not participate in sport. There is strong evidence that a history of neck pain, female gender and lack of physical activity are risk factors for development of WRNP (Ariëns et al. 2002; Cagnie et al. 2007; Cote et al. 2008; Korhonen et al. 2003; Paksaichol et al. 2012).

Her occupation involved long sitting periods at the computer, high quantitative job demands, limited rest opportunities and static neck and arm postures, which are all further risk factors for WRNP (Ariëns et al. 2001; Jensen et al. 2002; Korhonen et al. 2003; Kothiyal and Bjørnerem 2009). In addition, poor workstation ergonomics has been linked to increased risk of neck pain (Paksaichol et al. 2012).

An assessment of the vertical parameters of the participant's workstation established that her seat height was adequate and allowed her feet to be flat on the floor and her elbows to be at keyboard height, but that the monitor position was too low (see Table 2.1). Similarly, Ketola et al. (2002) found monitor height to be the most common workstation change required in the ergonomic intervention group of their study. They concluded that the apparent inattention to monitor height may result in preventable neck disorders if head and neck postures are a determinant of these conditions. In this case, the low monitor position possibly led to flexion of the neck and upper back, which is a further risk factor for WRNP (Ariëns et al. 2001). Baker and Moehling (2013) postulated that if the computer workstation and the anthropometrics of the worker do not match, this may lead to awkward postures placing stress on the musculoskeletal system and therefore result in MSDs.

According to the Entry Questionnaire the participant indicated that her pain was moderate, yet she experienced much lower pain levels throughout the study. The mean pain during the baseline and intervention phases was mild, while during the withdrawal phase her pain decreased to what is considered no pain, according to the interpretation of her VAS levels (Hawker et al. 2011). This improvement was not statistically or clinically significant, and the effect size of this change was small. This low initial pain score influenced the ability to achieve clinically significant changes due to the floor value of VAS pain. In addition, the large variability of the baseline scores led to large 2SD bands, resulting in no data points falling outside the bands for statistical significance. The continued improvement during phase C could be

attributed to the time it takes for affected musculoskeletal systems to respond to an ergonomic intervention (Aas et al. 2011). For this participant, the pain intensity variance decreased over the period of the study, which could indicate adjustment to the new posture and the resulting stability in symptoms.

The low pre-intervention baseline mean pain and comfort levels meant that it was unlikely that major improvement effects could be achieved by the intervention. Similar low baseline levels of pain lead Ketola et al. (2002) to conclude that no major effects could be expected. Although their study failed to show a statistically significant improvement in pain or discomfort ratings after an ergonomic intervention, the decrease in discomfort led them to hypothesise that discomfort is possibly more reversible than pain or strain and that discomfort could be a predecessor of pain (Ketola et al. 2002). Lindegård et al. (2012) found low perceived comfort to be a predictor of incident neck symptoms in computer users, indicating that there might be a relationship between pain and discomfort. For this participant, as illustrated by Figure 2.5, for the most part, there was a congruent relationship between pain and discomfort. However, there were also incidences where pain and discomfort were not congruent. 'Postural comfort' as used in the present study is defined as the absence of discomfort (Pearson 2009). Comfort does not necessarily mean the absence of pain, and discomfort does not always imply presence of pain, which leaves the relationship between pain and comfort/discomfort unclear, and warranting further investigation.

In this study, the participant's mean comfort of sitting position VAS levels initially increased slightly and then decreased, resulting in a small clinically and statistically insignificant improvement in the phase C. A possible explanation for the initial decrease in comfort might be that the participant had to adapt to the adjusted workstation and subsequent different posture. Baker and Moehling (2013) support this notion by stating that workstations adjusted to match anthropometrics may initially place more stress on tissues previously shortened by disuse. The computer user could thus feel more discomfort initially with a "correctly" adjusted workstation. A period of familiarisation following the adjustment of the workstation may thus be considered for future research. The variance of comfort measurements increased over the three phases, indicating that peaks of discomfort remained, perhaps on

days of increased work load demands. It is also plausible that the intervention decreased musculoskeletal pain but stressed the visual system more (Fostervold et al. 2006).

When interpreting the results of the study, one should take into consideration that the first part of the baseline phase coincided with the participant writing examinations for her part time studies, which could have added both a biomechanical and a psychosocial confounder to her symptoms due to her studying posture, increased time spent sitting and the stress of examinations. The decision was thus taken to extend the baseline phase. It is noticeable from visual analysis when analysing Figure 2.5 that her levels of pain and discomfort stabilised after the examination period, which is represented by the last six VAS points of the baseline phase. Phases B and C coincided with the tax year end which implicates higher workload at her workplace. The Exit Questionnaire and the post study interview indicate that the participant felt that her work load and work duration had remained similar for the duration of the study despite examinations and the tax year end. Interestingly though, both of these stressful events coincided with peaks in pain intensity and discomfort ratings, which could also be normal fluctuations typical of chronic musculoskeletal symptoms (Baker and Moehling 2013). Other potential confounders, such as treatment received, family, social or physical activity related changes, new glasses prescription, new mattress or any general health issues were conceivably eliminated by the Entry, Outcomes and Exit Questionnaires. The participant mentioned a coincidental change to a lower pillow when sleeping during phase B. As the participant's pain pattern did not relate to sleep, this is not likely to have affected the outcomes. The participant also reported feeling 80% satisfied with the intervention during the post study interview.

It is plausible that the changes were as a result of the intervention. The physical changes in work posture that occurred as a consequence of the intervention could have led to a better, more ergonomically acceptable, working posture, such as less neck flexion. This possible postural change towards neutral could have decreased the load and moment on the neck and reduced the activity in the neck and shoulder musculature. A physiological response of improved circulation, removal of waste products and increased nutrition could lead to less discomfort and fatigue in the

muscles (Mekhora et al. 2000). Robertson et al. (2003) adjusted workstations, including spatial design and lighting, and found a decrease in overall discomfort relative to a control group, which suggests that adjusting ergonomics is beneficial. However, their ergonomics plus training group reported a greater reduction in symptoms, leading them to conclude that using the adjusted workstation more ergonomically, possibly reduces musculoskeletal strain associated with computer work even further. A few studies have shown the benefit of adding training to the workstation adjustment (Pillastrini et al. 2007; Mirhommadi et al. 2012; Esmailzadeh et al. 2014).

The findings of this study contribute to the body of literature on ergonomic workstation adjustments in computer users with WRNP. The study findings indicate that adjusting the vertical parameters of the workstation may contribute to reducing neck pain and increasing comfort of the sitting position. It is possible that the observed improvement in symptoms was related to being included in a research investigation (the Hawthorne effect).

In a developing country such as South Africa, seat height and monitor height adjustments are cost-effective, time-efficient and easily applicable ergonomic tools for physiotherapists to use as part of the treatment of the computer worker. Physiotherapists can assist employers to implement this inexpensive strategy to address WRNP which can lead to increased staff wellness. Further benefits may include increased productivity, as neck and shoulder symptoms have been shown to be associated with a loss of productivity at work (Van den Heuvel et al. 2007). Monitoring of pain and comfort ratings is advisable to confirm the effectiveness of the intervention in individual computer users, especially as the visual system needs to be considered. Adding postural training seems to increase the benefit of an adjusted workstation. Ergonomics should possibly be tailor made for the individual rather than applying a fixed set of rules to all, as those computer users with graduated lenses may find the monitor height investigated in this study to be visually straining.

The main limitation of the study is that the N=1 participant volunteered and she was the only suitable candidate. The results thus cannot be generalised to larger populations. In addition, baseline measurements showed high variability and low pain and comfort levels. Participants with higher levels of pain and discomfort might

yield different results. Part-time studies should have been an exclusion criterion on the Screening Questionnaire, as the additional biomechanical and psychosocial stress can confound the results. Postural angle measurements could have resulted in clearer understanding as to where the participant's postural change took place anatomically. Finally, when researching the effect of interventions on office workers, it may be prudent to include measures that reflect productivity, as cost-effectiveness is an important aspect of ergonomics (Leysshon et al. 2010). Employers and funders may be more interested to see interventions translate into a benefit in terms of productivity, or decreased absenteeism or presenteeism.

The strengths of this study are the thorough assessment (a clinical history and a physical examination to confirm the symptoms) of the participant. In addition, the ergonomic adjustment involved only one parameter of the participant's workstation, the vertical height adjustment according to the anthropometry of the participant. No training, confounding advice or simultaneous use of other workstation adjustments deemed to be risk factors were introduced. The participant was compliant throughout the study period, lending this study more credibility.

Recommendations for further research include that research with a higher level of evidence and adequate sample size should be conducted to affirm ergonomic interventions. More research is also needed to develop standardised reliable and valid ways to measure pain and comfort, thereby facilitating good quality research on ergonomic interventions. The relationship between pain and comfort should be further explored. Standardising terminology will further facilitate comparison of findings across studies. Furthermore, a clear description of interventions is needed in studies, to enable clinicians to effectively implement these interventions.

2.6. Conclusion

The study aimed to determine the effect of adjusting the vertical parameters of a computer workstation, namely seat height and monitor height, on the WRNP of a computer worker. One female participant with WRNP participated in the study. The participant's pain intensity and the comfort of sitting position decreased during the study. However, these improvements were not clinically or statistically significant.

Our findings indicate that the vertical parameters of seat height and monitor height may be one aspect to address in computer users with WRNP.

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Chapter 3: Summary

3.1. Background

Work-related musculoskeletal disorders of the upper limb and neck are one of the most common occupational disorders globally (Cagnie et al. 2007, Hoe et al. 2013), with prevalence rates of 65 -75% reported in computer users (Cho et al. 2012, Griffiths et al. 2012, Tornqvist et al. 2009). The neck, shoulders and upper back areas are most commonly affected in this population (Cho et al. 2012, Eltayeb et al. 2011). The incidence may increase even further as an annual upward trend for computer use is observed, both for work and recreation (Green 2008). The increased usage can be attributed to a cultural adaptation to the convenience of new technology (Green 2008), as well as a shift in working practices towards the service and information sector (Boocock et al. 2007). The high prevalence of WRNP among computer workers can result in personal suffering and financial costs (Aas et al. 2011), as well as have an economic impact on the employer and the health system due to health costs associated with the rehabilitation of workers with musculoskeletal injuries, and economic costs as a result of compensation, loss of productivity and retraining (Bocock et al. 2007).

3.2. Contribution to the body of knowledge

Studies have found that MSS correlate with ergonomic factors (Esmailzadeh et al. 2014, Paksaichol et al. 2012, Robertson et al. 2003), which makes it plausible that ergonomic interventions may decrease the mental and physical load on workers and therefore prevent or reduce the risk of workers developing these musculoskeletal disorders (Hoe et al. 2013). Ergonomic interventions include individual worker interventions, physical work-related ergonomic interventions and organisational workplace ergonomic interventions. According to several systematic reviews, the effect of office ergonomic interventions on MSS in computer workers remains meagre (Aas et al. 2011, Brewer et al. 2006, Driessen et al. 2010, Kennedy et al. 2010), possibly as the individual study results can seldom be amassed and reviewed due to different interventions and populations researched. Some individual studies though have found a positive effect of multifactorial workstation and office environment adjustments (Amick et al. 2003, Esmailzadeh et al. 2014, Hedge et al. 2001, Ketola et al. 2002, Mekhora et al 2000), but this does not allow a conclusion

on which particular aspect of the intervention proved effective. Hoeben and Louw (2014) commented that ergonomic interventions used clinically by physiotherapists to help manage MSS in computer users are either not sufficiently researched or have not been investigated as a sole entity. There is thus a gap in the body of knowledge on the effect of specific ergonomic interventions for WRNP. Studies where one intervention is applied and possible confounders eliminated are needed. The aim of this study was to establish the effect that a single intervention in the form of a vertical monitor and chair height adjustment has on the neck and upper back pain and comfort of the sitting position as well as perceived disability in a computer user.

3.3. Study description

An N=1 study, A-B-C design, was undertaken with one female office worker with chronic WRNP and who used her computer for at least five hours per day. Two primary outcomes, “pain intensity” and “comfort of sitting position” were assessed using a VAS twice a week for the duration of the study. The NDI assessed self-reported disability and was administered at the beginning and at the end of the study. In addition, the participant was interviewed at the beginning of the study and she completed questionnaires at the commencement of the study, after each phase and at the end of the study, in order to identify possible confounding factors.

A baseline phase, followed by an intervention phase and ending with a withdrawal phase was implemented. The duration of each phase was planned to last four weeks. As the baseline phase was a potentially stressful period for the participant, and included a number of public holidays, it was extended in order to establish stability in the two primary outcome measures, pain and comfort of sitting position. The intervention consisted of adjusting both the height of the chair and the height of the monitor to match the anthropometrics of the participant. Her seat height did not require change and her monitor was elevated to the calculated height using the PC-SAFE guidelines (Hochanadel 1995). The data was collected and entered on a Microsoft Excel 2010 spread sheet.

The main findings of the results were a reduction in the mean of both the participant’s self-reported pain intensity and the comfort of sitting over the entire period of the study, but neither was clinically or statistically significant. The participant’s self-reported disability score depicting no disability, remained

unchanged. The mean value for self-reported pain was mild in the baseline and intervention phases, and reduced to what is considered no pain in the withdrawal phase. In addition a reduction in variance was observed as the study progressed, indicating that the participant experienced more consistent symptoms, with fewer intense pain episodes. Thus the assumption in workstation intervention strategies, that MSS can be reduced by eliminating discrepancies between the worker and the workstation was supported, even though the effect size for the overall improvement in self-reported pain was small. Comfort of sitting showed a slight decrease in comfort in the intervention phase, possibly due to stress placed on tissues previously shortened by disuse (Baker and Moehling 2003). The withdrawal phase had the participant indicate increased comfort of sitting position compared to baseline VAS values. The variance of the comfort scores increased as the study progressed through the three phases, indicating that the participant experienced days of less comfort, despite the trend to improved VAS comfort scores. The overall improvement in comfort had no clinical or statistical significance and the effect size from phase A to C was small.

3.4. Clinical Implications

The results show that there may be benefit in adjusting the monitor height to fit the office worker's anthropometrics. In this participant elevating the monitor could have resulted in a postural change of less cervical and upper thoracic flexion, bringing about a more neutral postural alignment, thus reducing the flexion moment on the cervical spine, and decreasing the activity of the posterior cervical musculature. This could have resulted in decreased self-reported pain and increased comfort, despite the low baseline VAS means of both outcomes making major improvement effects difficult to achieve. What lends further credibility to the effect of the intervention is that the participant retained the intervention monitor position throughout the withdrawal phase and the pain and comfort VAS scores continued to decrease. In addition, in a post study interview she reported being 80% satisfied with the intervention.

The vertical height changes to the workstation effected an improvement in the participant's self-reported pain and increased the comfort of her sitting position, and yet the participant was left with residual MSS. The researchers acknowledge that ergonomic interventions need to be multimodal. The residual MSS reported by the

participant could be attributed to a variety of factors, including individual or organisational work-related risk factors, physical workstation risk factors other than the monitor height mismatch, as well as the complexity of chronic pain.

Korhonen et al. (2007) found that employees, who exercised less frequently, as the participant did, demonstrated a higher risk of neck pain. This individual risk factor is modifiable, thus advising the participant to be physically active could potentially lead to further decrease in MSS.

The participant's occupation involved long sitting periods at the computer, high quantitative job demands and limited rest opportunities which are all further risk factors for WRNP (Ariëns et al. 2001; Jensen et al 2002; Korhonen et al. 2003; Kothiyal and Bjørnerem 2009). Encouraging the participant to have more frequent rest breaks could also contribute to improving left over symptoms. Rocha et al. (2005) found a strong association between WRNP and lack of rest breaks. Similarly, Cagnie et al. (2007) found rest breaks to have a protective effect, indicating that they may allow muscle relaxation as well as decreasing computer exposure.

The participant did not use a document holder and was required to flex and rotate her neck to refer to documentation placed to the left of her keyboard when working. Goostrey et al. (2014) found that the neck flexion required looking at documents on the table surface whilst working to be a risk factor for WRNP, whilst van den Heuvel (2006) identified rotation as a risk factor in neck/shoulder symptoms.

Visual analysis of Figure 2.2 shows that the participant placed her mouse beyond the keyboard close to her monitor. This could also potentially be a contributing factor in the participant's residual MSS, as Kiss et al. (2012) found that having the shoulder too abducted or too flexed to reach the mouse that is too far away, to be a risk factor for WRNP.

In addition this study purposefully did not provide the worker with postural education, as the researchers wanted to change only one parameter of the workstation, namely vertical height of the chair and the monitor. In chronic pain sensory motor interactions are affected (Baker and Moehling 2013); therefore adjusting the vertical parameters of the workstation may not necessarily result in a concomitant improvement of working posture. It would be prudent to add postural training to the management of the computer user with WRNP. Mirmohammadi et al. (2012)

demonstrated an improvement in the postures of computer workers at the workstation after ergonomic training.

The participant had a history of neck pain (Cote et al. 2008; Eltayeb et al. 2011; Paksaichol et al. 2012), and the treatment of chronic pain is complex and may require psychosocial factors to be addressed in addition to the many physical aspects mentioned above.

It remains useful to know that adjusting the vertical parameters of the workstation to fit the anthropometrics of the worker may well contribute to the management of WRNP in computer users and should be part of a multimodal management of this patient population. A simple calculation and subsequent adjustment of the monitor height resulted in the participant in the present study to feel 80% satisfied with the intervention. In addition she chose to keep the intervention monitor height in the withdrawal phase, reporting further improvement of both pain intensity and comfort of sitting position during this phase.

The findings of this study can be used to motivate employers to invest in adjustable chairs and implement ergonomics training. Firstly, seat height and monitor height adjustments are cost-effective, time-efficient and easily applicable ergonomic tools for physiotherapists to use as part of the treatment of a computer user with WRNP. This is supported by Hoeben and Louw (2014) who found that an expensive ergonomic chair was not superior to a low cost adjustable chair in improving MSS in the short term. Secondly, in research by van den Heuvel (2007), most workers with neck/shoulder symptoms or hand/arm symptoms experienced productivity loss from a decreased performance at work and not from absenteeism.

3.5. Strengths, Limitations and recommendations

The strength of the study is that only one component of the workstation was adjusted. Any known confounding factors were monitored; therefore the results are likely to be attributable to the specific intervention.

The main limitation of this study is the N=1 design, which means that studies with a larger number of participants are required before the results can be extrapolated to the general population. Postural angle measurements should be included so that the researchers have an objective measurement that a change in monitor height does result in a postural change. In addition, measures of productivity would be a useful

indicator whether a reduction in MSS results in increased productivity (van den Heuvel, 2007), making the study worthwhile for employees, employers and funders.

Chapter 4: Conclusion

The aim of this study was to ascertain whether a chair and monitor height adjustment would reduce WRNP in office workers who are computer users. The findings of this single subject study suggest that the vertical height adjustment of the chair and monitor to match the anthropometrics of the single female participant may have contributed to a decrease in self-reported pain and resulted in an increased perception of sitting comfort. This safe, economical workstation intervention may be a practical management option to add to the multimodal management of computer users suffering from WRNP. Further research with larger population studies are required to support these findings.

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Appendices

Appendix 1: Journal Guidelines

Guidelines for Authors

Contributions to the *South African Journal of Physiotherapy* are invited on any topic related to physiotherapy or rehabilitation. All articles that are submitted to the journal for publication must be accompanied by two questions with the correct answers.

Types of Manuscripts

1. Research
2. Case report
3. Clinical report
4. Technical report
5. Literature review
6. Short Report

All manuscripts should be accompanied by a reference list.

Legal Considerations

Contributions will be considered for publication in the *South African Journal of Physiotherapy* on condition that

- they have not been published previously.
- they have not been submitted for publication elsewhere.
- the Publications Division of the SASP reserves the copyright of all material published.

Acceptance of manuscripts

All manuscripts will be reviewed by two appointed referees. Identities of both authors and reviewers will be kept confidential in order to eliminate bias. Most articles require revision, in which case the reviewers' comments will be returned to the authors for consideration and alteration.

Preparation and Presentation of Manuscripts

Articles

1. Articles should be restricted to between 2 000 and 2 500 words.
2. Three copies submitted should be typewritten with double spacing and wide margins.
3. A title page should be supplied as a separate sheet and include the name(s), qualifications and affiliation(s) of the author(s), together with addresses and telephone numbers (at home and at work).
4. Each article must be accompanied by an abstract of not more than 200 words. This should be on a separate sheet and should be intelligible without reference to the main text. Up to five key words should be included.
5. All abbreviations should be spelt out when first used.
6. The metric system is to be used throughout.
7. Headings must be presented in upper and lower case. Avoid using capitals only.
8. Authors must provide contact details; telephone numbers and email as well as postal address and institutional affiliation (hospital, University).

Letters to the editor

- if a letter is intended for the correspondence column it should be marked "for publication".
- it should be no longer than 400 words.

References

The accuracy and the completeness of references are of the utmost importance, and a maximum of 15 references per paper is required.

1. References in the Text of the Article

When referring to more than one paper, place the names of the principal authors in alphabetical order, eg Armstrong (1990), Jones (1988) and Smith and Jones (1990) refer to similar findings.

When there are two authors of a paper, mention both, eg Smith and Jones (1990), but when there are three or more, mention only the principal author and follow with et al, eg Thomas et al (1980).

When citing an author's work within a sentence in the main text of your article, follow these examples:

- Smith (1982) refers to the length of time taken for the subject to respond to a stimulus.
- Smith and Jones (1990) refer to similar findings.
- Smith (1982) and Thomas et al (1980) refer to problems in the method.

If quoting directly from another author, place the words in inverted commas and include the page number on which the quotation appears. For example: The clinical significance of increased tension or interruption of free movement in neural tissues is well recognised ... (Yaxley and Jull 1990, p.143)

(Reference: Allison G (editor) 1997 Australian Journal of Physiotherapy Guidelines for Authors. In: Scientific Writers' Handbook. Australian Journal of Physiotherapy (publisher): 117)

2. Reference list

This should appear at the end of the paper in alphabetical order. The author's name should be followed by the initials (unpunctuated) and separated from the next author by a comma. The names of all the authors should be cited and et al should not be used in the reference list. Next should follow the date of publication and then the details of the publication.

- a) Journal articles. Having stated the authors and the year of publication, the title of the article should be given in full. There should be a full stop after the title. This should be followed by the full title of the journal (abbreviations should not be used), then the volume number (not the part number) followed by a colon and then the first and last pages of the publication. The required format is illustrated in the following example: Erickson M, Upshur C 1989 Caretaking burden and social support: Comparison of mothers of infants with and without disabilities. *American Journal of Mental Retardation* 94:250-258
- b) Books. The format as illustrated in the example should be followed. (Note the use of punctuation and capital letters¹).

- 1) Payton OD 1994 Research: The validation of clinical practice, 3rd edn. pp151-156. F.A. Davis Company, Philadelphia
- 2) Shephard KF 1993 Questionnaire design and use. In: Bork CE (ed) *Research in Physical Therapy*, pp176-204. J.B. Lippincott Company, Philadelphia

Illustrations

- Tables and figures should be kept to a minimum and be on separate sheets.
- Each table should be numbered and have a clear title. Tables should not repeat material stated in the text. All tables and figures must be referenced in the text in sequential order.
- Don't send photographs as an integral part of a Word document. Send them separately as a Jpeg file.
- All illustrations should be clearly marked on the reverse side with arabic numerals, author's name and article, and an indication of the top side.
- All legends must be typed on a separate sheet.
- If a figure has been published before, the author must submit written permission from the copyright holder to reproduce the material.

Manuscript submission

- A covering letter, which must include the signature of each co-author, should accompany each manuscript.
- Permission to reprint figures, extracts or abstracts from other publications should be included with the manuscript on submission.

Tick List:	Yes	No
Covering Letter		
Abstract 200 words		
Article content 2500 – 3000		
Short Report 1500		
References as indicated in guidelines		
3 CPD questions have been attached at the end of the article		

Appendix 2: Ethics Approval Letter



UNIVERSITEIT-STELLENBOSCH-UNIVERSITY
jou kennis agteruit • your knowledge matters

Approval Notice New Application

06-Dec-2013
van Vledder, Nicole N

Ethics Reference #: S13/10/215

Title: A simple ergonomic intervention for neck and upper back musculoskeletal pain in office workers.

Dear Ms Nicole van Vledder,

The **New Application** received on **11-Nov-2013**, was reviewed by members of **Health Research Ethics Committee 1** via Minimal Risk Review procedures on **04-Dec-2013** and was approved.

Please note the following information about your approved research protocol:

Protocol Approval Period: **06-Dec-2013 -06-Dec-2014**

Please remember to use your **protocol number** (S13/10/215) on any documents or correspondence with the HREC concerning your research protocol.

Please note that the HREC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

After Ethical Review:

Please note a template of the progress report is obtainable on www.sun.ac.za/rds and should be submitted to the Committee before the year has expired. The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number of projects may be selected randomly for an external audit.

Translation of the consent document to the language applicable to the study participants should be submitted.

Federal Wide Assurance Number: 00001372
Institutional Review Board (IRB) Number: IRB0005239

The Health Research Ethics Committee complies with the SA National Health Act No.61 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 Part 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).

Provincial and City of Cape Town Approval

Please note that for research at a primary or secondary healthcare facility permission must still be obtained from the relevant authorities (Western Cape Department of Health and/or City Health) to conduct the research as stated in the protocol. Contact persons are Ms Claudette Abrahams at Western Cape Department of Health (healthres@pgwc.gov.za Tel: +27 21 483 9907) and Dr Helene Visser at City Health (Helene.Visser@capetown.gov.za Tel: +27 21 400 3981). Research that will be conducted at any tertiary academic institution requires approval from the relevant hospital manager. Ethics approval is required BEFORE approval can be obtained from these health authorities.

We wish you the best as you conduct your research.
For standard HREC forms and documents please visit: www.sun.ac.za/rds

If you have any questions or need further assistance, please contact the HREC office at 0219389156.

Included Documents:

CV Louw
Cv Saggu
Decl Muller
Decl Louw

Appendix 3: Signed Informed Consent Form

11.8 Participant Information and Consent Form

PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM

TITLE OF THE RESEARCH PROJECT: A simple ergonomic intervention for neck and upper back musculoskeletal pain in office workers.

REFERENCE NUMBER:

PRINCIPAL INVESTIGATORS: Mrs N van Vledder, Mrs S Muller, Ms R Saggiu

ADDRESS: Division of Physiotherapy, Faculty of Health Sciences, Stellenbosch University, PO Box 19063, Tygerberg 7505, South Africa

CONTACT NUMBER:

- Nicole van Vledder on gavinix@hotmail.com or 0761019096
- Sabine Muller on sabinem@mweb.co.za or 0833754466
- Rajinder Saggiu on rsaggiu2@gmail.com or 0712777218

You are being invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the study staff or doctor any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is entirely voluntary and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the Health Research Ethics Committee at Stellenbosch University and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is this research study all about?

The aim of this study is to investigate the effect of modifying your office chair height and computer screen height on your neck and upper back pain. The study will be conducted in your office at your present workstation. Two participants from your office have been chosen to participate in the study. A similar study will be conducted at two other sites by two additional researchers, bringing the total number of participants to six.

40

The procedure is as follows: For four weeks your workstation will remain unchanged. During this time we will measure your symptoms biweekly using a questionnaire. You will be asked to score the intensity of your neck and upper back pain and the perceived comfort of your work position over the previous two days. This will take less than one minute to complete and place in the folder provided. This phase allows us to establish your baseline symptoms when you are working at your usual workstation.

Thereafter your workstation will be adjusted, and for a further four weeks biweekly monitoring of your symptoms will continue.

You will then be able to adjust your workstation to a setting of your choice should you wish to, and a final four weeks of biweekly monitoring will take place.

Why have you been invited to participate?

You have been invited to participate in this study because you are a computer-based office worker and suffer from chronic neck and upper back pain. You meet all the required criteria of the research study.

What will your responsibilities be?

You are expected to participate in this study for the duration of twelve weeks in total. This will involve completing the bi-weekly questionnaire and placing it in the slotted sealed box provided by the researcher.

During the first 8 weeks we request you not to change the height of your office chair or computer screen. Should you for any reason feel that an adjustment is necessary, please contact us.

Will you benefit from taking part in this research?

You may benefit from this research, as your workstation adjustment will be done according to recent evidence based literature. The results of our study may benefit others with similar symptoms related to office work which involves using a computer.

Are there any risks involved in your taking part in this research?

There are no additional risks from taking part in this study. In the event that the adjustments made to your workstation aggravate your neck and upper back symptoms please feel free to contact me.

If you do not agree to take part, what alternatives do you have?

You are able to have your workstation assessed by contacting a private physiotherapist, ergonomist or be referred to a professional in this field by the researcher. They would assess the possible contribution of your workstation to your neck and upper back pain.

Who will have access to your medical records?

All information provided by you will remain confidential and your identity will remain anonymous. No access to your medical records is necessary for the study.

Will you be paid to take part in this study and are there any costs involved?

You will not be paid to take part in this study, nor are there any costs involved for you, if you do take part.

Is there anything else that you should know or do?

You can contact the Health Research Ethics Committee at 021-938 9207 if you have any concerns or complaints that have not been adequately addressed by your researcher.

You will receive a copy of this information and consent form for your own records.

Declaration by participant

By signing below, I [redacted] agree to take part in a research study entitled 'A simple ergonomic intervention for neck and upper back musculoskeletal pain in office workers.'

I declare that:

- I have read the attached information leaflet and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (place) four bay On (date) 08/09/2014
2014.

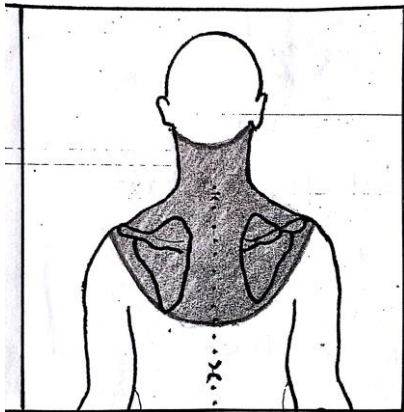
[Signature]

Signature of participant

Appendix 4: Screening Questionnaire

NAME: _____

Do you experience pain in the following shaded region whilst working on the computer?



Yes	No

If you have answered NO to the above question, please return the questionnaire

If you have answered YES to the above question, please fill out the following:

1. Are you between 18 and 65 years old?
2. Have you had this pain over the past 3 months?
3. Are you planning on undergoing any treatment for this neck &/ upper back pain in the next 3 months?
4. Do you experience more pain while working at your desk on your computer?
5. Do you spend at least a minimum of 5 hours a day on your computer?
6. If you work on a laptop, would you be prepared to use a separate keyboard/ mouse?
7. Can your chair and computer screen height be adjusted?
8. Do you wear bifocals/ varifocals while working?
9. What is your weight? _____

YES	NO

10. What is your height? _____

11. Do you smoke?

--	--

12. Are you pregnant?

--	--

13. Have you had any trauma to your neck/ or upper back?

--	--

e.g. whiplash, falls, any other accidents?

If YES please specify _____

14. Have you undergone any surgical procedure to your neck/ or upper back?

--	--

If YES please specify _____

15. Have you planned on taking leave from work over the next 3 months?

--	--

Appendix 5: Participant's Workstation Adjustment**Workstation Adjustment**

The following measurements need to be made at each workstation:

Measurement	mm
Habitual chair seat height (centre of front edge of seat pan to ground) SH(h)	
Habitual VDT height (top of monitor to floor) VDT(h)	
Table height	
Elbow to chair height	
Eye to chair height	

The following can now be calculated:

Measurement	PC-SAFE calculation	mm
Elbow height	Table height + 25 mm	
Adjusted chair seat height SH(a)	Elbow height - Elbow to chair height	
Adjusted VDT height VDT(a)	Eye to chair height + chair seat height	

Appendix 6: The Neck Disability Index

Neck Disability Index

This questionnaire has been designed to give us information as to how your neck pain has affected your ability to manage in everyday life. Please answer every section and **mark in each section only the one box that applies to you**. We realise you may consider that two or more statements in any one section relate to you, but please just mark the box that most closely describes your problem.

Office Use Only

Name _____

Date _____

Section 1: Pain Intensity

- I have no pain at the moment
- The pain is very mild at the moment
- The pain is moderate at the moment
- The pain is fairly severe at the moment
- The pain is very severe at the moment
- The pain is the worst imaginable at the moment

Section 2: Personal Care (Washing, Dressing, etc.)

- I can look after myself normally without causing extra pain
- I can look after myself normally but it causes extra pain
- It is painful to look after myself and I am slow and careful
- I need some help but can manage most of my personal care
- I need help every day in most aspects of self care
- I do not get dressed, I wash with difficulty and stay in bed

Section 3: Lifting

- I can lift heavy weights without extra pain
- I can lift heavy weights but it gives extra pain
- Pain prevents me lifting heavy weights off the floor, but I can manage if they are conveniently placed, for example on a table
- Pain prevents me from lifting heavy weights but I can manage light to medium weights if they are conveniently positioned
- I can only lift very light weights
-

- I cannot lift or carry anything

Section 4: Reading

- I can read as much as I want to with no pain in my neck
- I can read as much as I want to with slight pain in my neck
- I can read as much as I want with moderate pain in my neck
- I can't read as much as I want because of moderate pain in my neck
- I can hardly read at all because of severe pain in my neck
- I cannot read at all

Section 5: Headaches

- I have no headaches at all
- I have slight headaches, which come infrequently
- I have moderate headaches, which come infrequently
- I have moderate headaches, which come frequently
- I have severe headaches, which come frequently
- I have headaches almost all the time

Section 6: Concentration

- I can concentrate fully when I want to with no difficulty
- I can concentrate fully when I want to with slight difficulty
- I have a fair degree of difficulty in concentrating when I want to
- I have a lot of difficulty in concentrating when I want to
- I have a great deal of difficulty in concentrating when I want to
- I cannot concentrate at all

Section 7: Work

- I can do as much work as I want to
- I can only do my usual work, but no more
- I can do most of my usual work, but no more
- I cannot do my usual work
- I can hardly do any work at all
- I can't do any work at all

Section 8: Driving

- I can drive my car without any neck pain
- I can drive my car as long as I want with slight pain in my neck
- I can drive my car as long as I want with moderate pain in my neck
- I can't drive my car as long as I want because of moderate pain in my neck
- I can hardly drive at all because of severe pain in my neck
- I can't drive my car at all

Section 9: Sleeping

- I have no trouble sleeping
- My sleep is slightly disturbed (less than 1 hr sleepless)
- My sleep is mildly disturbed (1-2 hrs sleepless)
- My sleep is moderately disturbed (2-3 hrs sleepless)
- My sleep is greatly disturbed (3-5 hrs sleepless)
- My sleep is completely disturbed (5-7 hrs sleepless)

Section 10: Recreation

- I am able to engage in all my recreation activities with no neck pain at all
- I am able to engage in all my recreation activities, with some pain in my neck
- I am able to engage in most, but not all of my usual recreation activities because of pain in my neck
- I am able to engage in a few of my usual recreation activities because of pain in my neck
- I can hardly do any recreation activities because of pain in my neck
- I can't do any recreation activities at all

Score: ___/50 Transform to percentage score x 100 = %points

Scoring: For each section the total possible score is 5: if the first statement is marked the section score = 0, if the last statement is marked it = 5. If all ten sections are completed the score is calculated as follows:

Example: 16 (total scored)
50 (total possible score) x 100 = 32%

If one section is missed or not applicable the score is calculated: 16 (total scored)
45 (total possible score) x 100 = 35.5%

Minimum Detectable Change (90% confidence): 5 points or 10 %points

NDI developed by: Vernon, H. & Mior, S. (1991). The Neck Disability Index: A study of reliability and validity. Journal of Manipulative and Physiological Therapeutics. 14, 409-415

Appendix 7: Entry Questionnaire

Date: 07 April 2014

Age: 35 years

Sex: MALE/ FEMALE

Name: H.K.

Upper Limb dominance: RIGHT/ LEFT

Occupation: Accountant clerk

Frequency of breaks from sitting computer work: 2-3x per day

Shoe heel height commonly worn to work: no heel

Hobbies:none. No time, studying part-time for a B. Comm. degree

Sports/ recreation: none

Frequency of sports/ heavy physical activity causing sweating during the past 4 months?

More than 3 times/ week

1-2 times/ week

1-3 times/month

Less than 1 time/month

Social/family situation (and any recent changes which may impact on the neck or upper back symptoms): single, lives with two sisters and own child. Exams for her studies coming up in May, that she finds stressful

General Health: If yes, what treatment are you currently receiving?

Rheumatoid arthritis: no

Diabetes: no

High Blood Pressure: no

Osteoporosis: no

History of Cancer: no

History of Tuberculosis: no

Unexplained night sweats: no

Have you undergone any recent surgeries? no

Pharmaceutical history:

Are you currently taking any medication for chronic diseases: please specify: no

Have you previously or are you currently taking cortisone for longer than a 2 week period?
no

Are you currently taking any medication for pain relief? Please specify which one, and how often? For the neck and shoulders uses Deep Freeze. For headaches uses Panado/Myprodol? Grandpa 3x/week.

Have you noticed any of the following symptoms: no

Changes in the bladder and bowel patterns: no

Pins and needles in your hands and / feet: no

Changes in your walking pattern/ unsteadiness in the gait: no

Balance problems: no

Dizziness or fainting: no

Unexplained weight loss: no

Participant's main complaint (with respect to impact): upper back pain, which does not impact on her work, but when she gets home, she feels needs to rest because of it, her sister prepares dinner.

What is the participants **idea of causation, concerns, expectations** regarding their neck and upper back symptoms: She thinks the symptoms are caused by stress, posture, and seems to think that the symptoms could go away if addressed properly

History of neck and upper back symptoms

Current : present symptoms fairly constant since 3 months, but have been there on/off since 2010/2011

Past Relevant: Migraines until age 16. Since 2010/2011 present symptoms, insidious onset, episodic.

Specific questions

Pillow (size and content): 1 flat synthetic pillow

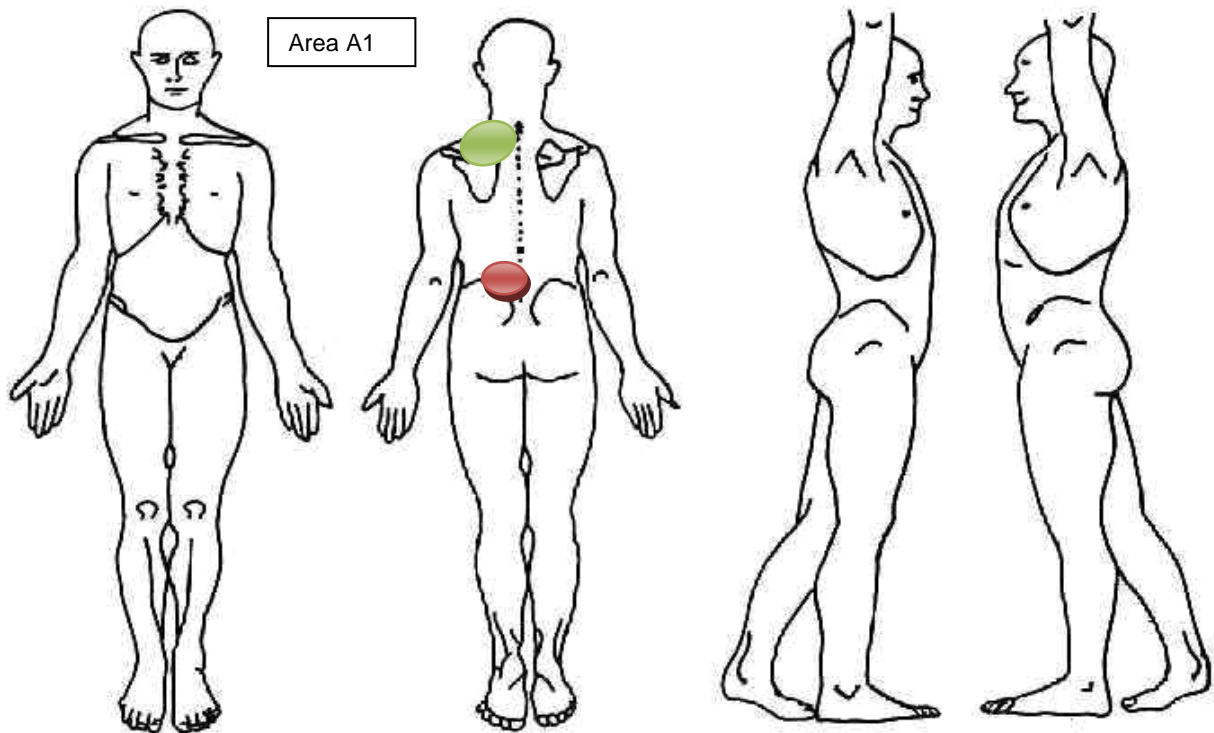
Bed mattress (age and firmness): 4 years old, getting soft

Sleeping position: side lying

Glasses (when used, last optometry appointment or script change, when due for another change?): myopic, wears glasses, last tested 2013 and script was adjusted.

Driving, carrying, sleeping, working, reading, other (if not already discussed): No pain in the morning (too busy?), sitting in the bus on the way to work, becomes aware of turning the thoracic area to turn to look to the left, does feel increased pain over the day sitting at work.

Special investigations: none



Area A1	Area A2
Nature: muscle spasm,tight	Nature: ache
Severity: 5/10	Severity: "not bad"
Depth: superficial	Depth: superficial
Constant/ <u>Intermittent</u>	Constant/ <u>Intermittent</u>

A1 and A2 are not related

Behaviour of Symptoms: specify 'work days' and 'non work days'

	AREA A1
24 hr pattern	No night pain. Pain free and unaware of A1 on rising and getting ready for work. Sometimes finds herself turning the body to turn the head on the bus to work. Feels it after having been at work for 2-3hrs. In the evening at home, after work, feels the need to rest. Weekends definitely better.
Aggravating Factors	The action of sitting and working at the computer

Relieving Factors	Deep Freeze, massage rub.
-------------------	---------------------------

The Generic Condition Screening Tool:

Thinking about the **last 2 weeks** tick your response to the following questions:

	Disagree	Agree
	0	1
1 It's really not safe for a person with (neck and upper back symptoms) a condition like mine to be physically active	<input checked="" type="checkbox"/>	<input type="checkbox"/>
2 Worrying thoughts have been going through my mind a lot of the time in the last 2 weeks	<input checked="" type="checkbox"/>	<input type="checkbox"/>
3 I feel that my (neck and upper back symptoms are terrible) problem is terrible and that it's never going to get any better	<input checked="" type="checkbox"/>	<input type="checkbox"/>
4 In general in the last 2 weeks, I have not enjoyed all the things I used to enjoy	<input checked="" type="checkbox"/>	<input type="checkbox"/>

5. Overall, how bothersome have your neck and upper back symptoms been in the last 2 weeks?

Not at all	Slightly	Moderately	Very much	Extremely
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
0	0	0	1	1

Score: 0/5

Physical Examination

Observation: slight forward head on neck posture

Functional demonstration of most problematic movement, if applicable: turning to look over her left shoulder.

Movement Tests (record ROM, quality of movement through range and end feel, overpressure where applicable, pain response):

Cervical	Flexion	√√
	Extension	√√
	Right Rotation	√√
	Left Rotation	√ 1/10, 4/10 with overpressure
	Right Side Flexion	√√
	Left Side Flexion	√ 2/10, 5/10 with overpressure
Thoracic	Flexion	√√
	Extension	√ 0/10, on overpressure discomfort across T9
	Right Rotation	√ 0/10, on overpressure central tightness T9 level
	Left Rotation	√ 0/10, on overpressure same central tightness at T9
	Right Side Flexion	√ 0/10, on overpressure tightness right mid-axillary line
	Left Side Flexion	√ 0/10, on overpressure tightness left mid-axillary line
Shoulder	Flexion	Right and left shoulders √√
	Hand behind back	Left shoulder √√. Right shoulder has 5 cm ↓range of movement, pain right anterior glenohumeral joint

Palpation:

Increased tone palpated in left upper trapezius.

Left unilateral posterior-anterior pressure C6 Grade 4- hypomobile and tender locally

Neural mechanosensitivity:

Median Nerve Tension Test 1: left =right, both pull in cubital fossa at -10°.

Appendix 8: Outcome Measures Questionnaire

Outcome Measures Questionnaire

Date: _____

Dear _____

1. Please mark your average pain intensity in the neck and upper back over the previous two days by placing ONE 'X' on the line.

No Pain

Worst Possible Pain

2. Please mark your average "comfort level", while sitting at work over the previous two days, by placing ONE 'X' on the line.

Very Comfortable

Extremely Uncomfortable

3. Have you taken any medication for your neck or upper back pain over the previous two working days?

Yes	No
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If you answered Yes, what medication have you taken and how frequently have you taken it?

What effect has this pain medication had?

Please place this form in the sealed box. Thank you for your time.

Appendix 9: End of Phase Questionnaire

Phase End Questionnaire

(Please complete this questionnaire in addition to the 'Outcome Measures Questionnaire')

Dear _____ Date: _____

<p>1. Have you been absent from work in the past 4 weeks? If yes, which dates were you absent?</p>	<p>Yes</p>	<p>No</p>
<p>2. Have you received any treatment (such as physiotherapy, chiropractic or other) for _____ your neck or upper back pain over the past 4 weeks? If yes, what treatment have you received? What effect has this treatment had?</p>	<p>Yes</p>	<p>No</p>
<p>3. Have you made any adjustments to your workstation over the past month? If yes, please describe the adjustments that you have made.</p>	<p>Yes</p>	<p>No</p>
<p>4. Is there anything else that you think may have influenced your neck or upper back pain/comfort in the past 4 weeks? (e.g. a change in the work environment, changes at home, an accident, etc.) If yes, please specify</p>	<p>Yes</p>	<p>No</p>

Please place this form in the sealed box. Thank you for your time.

Appendix 10: Exit Questionnaire

Exit Questionnaire

(Please complete this questionnaire in addition to the 'Outcome Measures Questionnaire')

Dear _____

Date: _____

1. Have you been absent from work in the past 4 weeks? If yes, which dates were you absent?		Yes	No
2. Have you received any treatment (such as physiotherapy, chiropractic or other) for _____ your neck or upper back pain over the past 4 weeks? If yes, what treatment have you received? What effect has this treatment had?		Yes	No
3. Have you made any adjustments to your workstation over the past month? If yes, how did you change your workstation? (please tick the appropriate box)		Yes	No
Back to my original settings	Back to the adjusted settings for the study	Other change	
If you chose 'other change', please describe which changes you made:			

4. Is there anything else that you think may have influenced your neck or upper back pain/comfort in the past 4 weeks? (e.g. a change in the work environment, changes at home, an accident, etc.)	Yes	No
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If yes, please specify:			
5. Has the nature of your work changed over the past 3 months? If yes, please specify:		Yes	No
6. Has your physical work environment changed over the past 3 months (e.g. a change in the lighting, desk, chair, computer, mouse or other equipment)? If yes, please specify:		Yes	No
7. How frequently do you take breaks from your sitting work?	Every 2 hours	Less often than every 2 hours	
8. Have you changed the frequency of your physical activity (exercise) in the past 3 months? If yes, please specify:		Yes	No
9. Have there been any major changes in your family and social life in the past 3 months? (e.g. moving house, changes in important relationships) If yes, please specify:		Yes	No
10. Have you had any accidents or injuries that may have affected your neck or upper back in the last 3 months (e.g. whiplash accident or a fall)? If yes, please specify:		Yes	No
11. Have there been any changes in your general health in the past 3 months? If yes, please specify:		Yes	No
12. Have you changed your mattress in the past 3 months? If yes, please specify:		Yes	No
13. Have you changes your pillow in the past 3 months? If yes, please specify:		Yes	No

14. Have you changed your glasses prescription in the last 3 months? If yes, please specify:	Yes	No
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Please place this form in the sealed box. Thank you for your time.