

# Ergonomic workstation intervention

Effect of a chair and computer screen height adjustment on neck and upper back musculoskeletal pain and sitting comfort in office workers.

Thesis presentation, in the format of a journal article (pre-peer reviewing material), in partial fulfilment of the requirements for the degree of Master of Science in Physiotherapy (Structured) OMT in the Faculty of Medicine and Health Sciences at Stellenbosch University



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# DECLARATION

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## Declaration

I, the undersigned, hereby declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

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# ABSTRACT

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**Aims:** To assess the effect of a vertical height adjustment of the chair and visual display unit (VDU) on work related upper quadrant musculoskeletal pain (WRUQMP) and sitting comfort in computer users.

The upper quadrant refers to the occiput, cervical and upper thoracic spine including the clavicles and scapulae.

**Methods:** An N=1 study was conducted using the ABC design whereby an ergonomic workstation adjustment, of VDU and chair height, was compared to the subject's usual workstation settings. Pain and sitting comfort were measured using visual analogue scales (VAS). The subject was assessed over the four week phases as she performed her typical VDU work. The results were compiled and tabulated.

**Results:** Both the mean and variance in pain intensity decreased after the workstation intervention. A deterioration was noted in sitting comfort.

**Conclusion:** The vertical height adjustment of the chair and VDU may have contributed to a decrease in WRUQMP in this subject. This safe, economical workstation intervention may be a practical management option for the computer user suffering from WRUQMP. Further research into the measurement of comfort whilst sitting at a computer workstation, is recommended.

## OPSOMMING

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**Doelwitte:** Om die effek te bepaal van n vertikale aanpassing van die stoel en beeldskerm van rekenaargebruikers op werksverwandte boonste kwadrant muskuloskeletale pyn en sitgemak. Die boonste kwadrant verwys na die oksiput, servikale en boonste torakale werwelkolom en sluit ook die klavikel en skapula in.

**Metode:** Die N=1 studie is onderneem met gebruik van die ABC ontwerp in terme waarvan n ergonomiese aanpassing van stoel en beeldskerm vergelyk is met die normale gebruik van die deelnemer. Pyn en sitgemak is gemeet deur die gebruik van die Visueel analoogskaal. Die interwensies is ge-evalueer oor vierweefases tydens normale rekenaar gebruik van die deelnemer. Die resultate is saamgestel en getabuleer.

**Uitkoms:** Beide die gemiddelde en veranderlike pynintensiteit het verminder nadat die werkstasie aangepas is. Geen verbetering in sitgemak is opgemerk nie.

**Gevolgtrekking:** Die vertikale hoogte-aanpassing van die stoel en beeldskerm het moontlik bygedra tot die verminderde pynvlakke in hierdie deelnemer. Hierdie veilige, ekonomiese verstelling is moontlik n praktiese beheeropsie vir rekenaargebruikers wat werksverwandte boonste kwadrant muskuloskeletale pyn verduur. Verder studie in die meet en waarneming van sitgemak tydens rekenaarwerk is nodig.

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# LIST OF ABBREVIATIONS AND DEFINITIONS

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## List of abbreviations:

MCID	Minimal clinically important difference
MSD	Musculoskeletal disorder
ROM	Range of motion
WRUQMP	Work related upper quadrant musculoskeletal pain
VADS	Visual analogue discomfort scale
VAPS	Visual analogue pain scale
VDU	Visual display unit
SR	Systematic Review
RCT	Randomised control trial

## List of definitions:

WRUQMP	The upper quadrant refers to the occiput, cervical and upper thoracic spine including the clavicles and scapulae (Brink and Louw 2013).
MSD	Musculoskeletal disorders refer to injuries or pain in the body's joints, ligaments, muscles, nerves, tendons and structures that support the limbs, neck and back ( <a href="http://www.cdc.gov/niosh/programs/msd">http://www.cdc.gov/niosh/programs/msd</a> ).
Hawthorne Effect	The Hawthorne effect (also referred to as the observer effect) is a type of reactivity in which individuals improve an aspect of their behaviour in response to their awareness of being observed (Adair, 1984).
VDU work	The use of keyboard or other input device, including short thinking periods and checking the results on the screen (Korhonen et al 2003).

# CHAPTER 1: LITERATURE REVIEW

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## 1.1 Introduction

Prolonged computer use has become customary in present-day office work environments (Wahlstrom et al 2004). This trend is mirrored by an increase in work related upper quadrant musculoskeletal pain (WRUQMP) especially among those who are intensive computer users (Jensen 2003, Paksaichol et al 2012a, Pillastrini et al 2010, Punnett and Bergqvist 1997). Furthermore, the risk factors associated with WRUQMP are multidimensional in nature, and the interaction which occurs between risk factors is well acknowledged (Johnston et al 2009).

Earlier studies confidently identified a causal association of musculoskeletal disorders (MSDs) and computer work with statements such as “there is adequate scientific knowledge regarding specific aspects of visual display unit (VDU) work to prevent many of the MSDs” (Tittiranonda et al 1999, p.17-38). However, recently researchers questioned the causal relationship of the computer workstation posture and MSD (Andersen et al 2011, Eltayeb et al 2011, Evans and Patterson 2000, Richter et al 2012). Mixed outcomes yielded by ergonomic intervention studies (Andersen et al 2011) as well as multifaceted interventions precluded distinct deductions relating to workstation adjustments and MSDs (Esmaeilzadeh et al 2014). The general computer based working population is of the opinion that prolonged computer work causes neck pain. A search of the ‘yahoo’ database using the terms ‘computer use and neck pain’ produced 47,300,000 results in June 2014. Numerous products claim to reduce neck pain in the workplace, based on the widely accepted public opinion that it is the worker’s posture at the computer workstation which causes the pain [[www.necksolutions.com/neck-pain-computer.html](http://www.necksolutions.com/neck-pain-computer.html) and many others].

The increase in WRUQMP in computer users is of individual as well as economic concern, with notable cost implications due to absenteeism, decreased productivity and health care expenditure (Heinrich et al 2004). Clinical advice, workplace policies as well as government legislative policies need to be based on trustworthy scientific

evidence (Waersted et al 2010). This review will concentrate on the recent evidence relating to WRUQMP in office workers who are computer users. The multiple risk factors and interventions identified in the literature will be summarised, and the literature relating chair and VDU height to WRUQMP, discussed.

## 1.2 The extent of the problem

Computer users are at an increased risk of WRUQMP (Cagnie et al 2007, Gerr et al 2004a, Jensen 2003). Table 1.1 demonstrates the occurrence of WRUQMP published over the past ten years. The research represented in Table 1.1 includes secretarial and managerial groups, as well as studies from developed and developing countries. Of concern is that the literature demonstrates that WRUQMP has not decreased in the past decade, despite much research in this area and advances in computer workstation ergonomics.

**Table 1.1: The extent of WRUQMP in computer users**

Study	Subject population group	Findings (incidence or prevalence) and study limitations
Korhonen et al (2003)	Office VDU workers in Finland (n=515). Although published in 2003, this study data was collected in 1998.	Annual <i>incidence</i> for neck pain: 34.4%. Limitations: respondents more stressed than non-respondents and VDU working time was self-reported with workers tending to overestimate their VDU working time. The criteria for incident neck pain was at least 8 days of pain in the preceding 12 months, which may have been difficult to recall.
Cagnie et al (2007)	Office VDU workers in Belgium (n=512).	Twelve month <i>prevalence</i> of neck pain: 45.5%. Limitations: Possible selection bias from a healthy workers effect cannot be excluded as subjects were recruited from workplaces only. Subjects reported neck pain that had occurred during the past 12 months, possibly leading to difficulty in recall. Exposure was self-reported and subjects with pain may rate their exposure higher than those without complaints (Van den Heuvel et al 2006).
Evans and Patterson (2000)	Managerial and professional computer users in Hong Kong (n=170). Population group non-secretarial and not	Neck or shoulder pain <i>during the previous month</i> : 65%. Limitation: Subjects with neck or shoulder pain may have increased tension as a result of the pain. It is not possible to establish temporality (did the neck or

	necessarily typing proficient.	tension come first) with a cross-sectional study design.
Tornqvist et al (2009)	Computer operators in Sweden (n=1283)	<i>Incident rate</i> of 67% (neck), 41% (shoulder). Limitations: Both exposures and outcomes were self-reported. The validity of self-reported physical exposures has been questioned (Mikkelsen et al 2007). Furthermore, beliefs regarding associations between exposure and symptoms, due to the debate in the media, may bias symptom reporting.
Griffiths et al (2012)	Public sector computer workers in Australia (n=934)	Twelve month <i>prevalence</i> of MSD highest in the neck area (> 70%) across all occupational groups. Limitations: Low response rate of 12%, alleged to be due to the online survey protocol used. Selection bias possible as subjects with existing problems may be more likely to participate, or conversely, survivor bias may reduce the reporting of symptoms. Potential over-estimation of exposure amongst those participants who were symptomatic (Mikkelsen et al 2007).
Kaliniene et al (2013)	Public sector computer workers in Lithuania (n=513)	<i>Prevalence</i> of 65.7% (neck), 50.5% (shoulder), 44.5% (upper back) MSD. Limitations: 94.7% of the study participants were women. Bias may have resulted as subjects were recruited from the workplace only and those who agreed to participate (possibly with current symptoms) were included in the study. Study subjects were not randomly chosen.
Cho et al (2012)	Office VDU workers in Taiwan (n=203)	<i>Prevalence</i> for neck MSD: 75.6%. The response rate to the self-report internet based questionnaire was low which may have resulted in responder bias. Furthermore, some of the high workload office workers may not have time to answer these questions. However, the study represents a high computer workload group, and so the results may lead to an overestimation of the prevalence of such symptoms for general computer users.
Eltayeb et al (2011)	Office VDU workers in Sudan, (n=250). Population group not in a high – income country.	1 year follow up MSD <i>prevalence</i> rate was 63% (neck) and 56% (shoulder) Limitations: Assessment of physical exposures was based on self-report, possibly resulting in overestimation of exposure in symptomatic subjects (Mikkelsen et al 2007). The questionnaire items did not include actual information on neck and monitor position. The subjects work in what are considered

		‘topnotch’ companies in Sudan and may feel privileged to be working in such environments, potentially leading to an underestimation of the effect of work-related physical factors.
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Most of the studies in Table 1.1 are cross-sectional studies allowing the researchers to compare many different exposures and outcomes in one study. However, cross-sectional studies involve data collected at a defined time. Hence, these studies do not provide information about the cause and effect relationships between the exposure and outcomes. Therefore these cross-sectional studies cannot ascertain whether the WRUQMP was in fact caused by computer usage.

### 1.3 General risk factors associated with WRUQMP

Multiple risk factors are associated with WRUQMP in office workers who are computer users (Johnston et al 2009). These risk factors may be non-modifiable or modifiable. Non-modifiable risk factors include higher age and female gender as well as genetic predisposition and structural spinal disorders. Modifiable risk factors include workstation postural factors, physical office environment and psychosocial workplace factors (Aarås et al 1998). Modifiable individual factors, such as being physically active outside of work, also play a role (Korhonen et al 2003). Table 1.2 shows the risk factors, other than workstation ergonomic risk factors, identified in the literature over the past decade.

**Table 1.2: Risk factors for WRUQMP in computer users**

Risk factor	Research study identifying the risk factor
Higher age ( >30years)	<b>Cagnie et al (2007):</b> Cross sectional study (n=512)
Female gender	<b>Paksaichol et al (2012b):</b> SR of 7 prospective cohort studies (1980-March 2011)  <b>Waersted et al (2010):</b> SR of 22 studies all including a physical examination (updated to February 2010)  <b>Evans and Patterson (2000):</b> Epidemiological field study

	(n=170)
Previous history of neck pain	<b>Paksaichol et al (2012a)</b> SR of prospective cohort studies (1980-March 2011);  <b>Huysmans et al (2012)</b> : Prospective cohort study with a follow up duration 2 years (n= 1951)
Less physical activity outside work (<1/week)	<b>Korhonen et al (2003)</b> : Prospective cohort study follow up duration 1 year (n=232).
Moderate evidence for computer use as a risk factor, unclear if association is causal	<b>Andersen et al (2011)</b> : SR of 8 reviews (1999-2010)
Subjectively rating the physical work environment as poor (Lighting, temperature, quality of the air, size of the working room and acoustics)	<b>Korhonen et al (2003)</b> : Prospective cohort study follow up duration 1 year (n=232)
Workplace psychosocial factors (intensified workload, time pressure, low job control, monotonous work, and low support from co-workers and management)	<b>Cagnie et al (2007), Devereux et al (2002), Evans and Patterson (2000), Griffiths et al (2007), Tornqvist et al (2009).</b>  The epidemiological field study (n=170) ) performed by Evans and Patterson (2000) noted that workers with neck or shoulder pain are likely to have increased muscle tension and it is hard to predict whether the neck pain or the muscle tension came first. <i>Not supported by the review by Paksaichol et al (2012).</i>
Combined effect of physical and psychosocial risk factors on neck pain is greater than the sum of the individual elements. Low supervisor support the dominant psychosocial risk factor.	<b>Johnston et al (2009)</b> :Self-report survey of n=333 female office workers
High psychosocial distress related to neck, shoulder and upper back MSD.	<b>Eltayeb et al (2011), Cho et al (2012).</b>
Dose-response relationship between sitting posture and neck pain	<b>Ariens et al (2000)</b> : Prospective cohort study with a three year follow up (n=1334 workers across various occupations).  <b>Kamwendo (1991), Skov et al (1996)</b>
Association between pain complaints and the intensity of	<b>Andersen et al (2011)</b> : A quantitative dose-response relationship could not be calculated due to the fact that

computer use (hours per day)	different studies have used different measures of exposures and outcomes. <b>Griffiths et al (2012)</b> : cross sectional study, (n=934 completed surveys, 8000 surveys distributed electronically); <b>Gerr et al (2006)</b> : SR of 39 papers (1983 - 2005); <b>Waersted et al (2010)</b> : SR of 22 studies all of which included a physical examination; <b>Rahman and Atiya (2009)</b> : cross sectional study (> 5 hours/day; n=463); <b>Keswani et al (2013)</b> : descriptive study (> 5 hours/day; n=249); <i>Not supported by</i> <b>Richter et al (2012)</b> :prospective cohort study over 2 years (n=1951) which found no indication that high peaks in computer use were related to the occurrence of neck MSD. Peak days > 4 hours VDU work.
More than 2 hours computer work without a break	<b>Kaliniene et al (2013)</b> : epidemiological study (n=513). <i>Not supported by</i> a SR performed by <b>Brewer et al (2006)</b> , which showed moderate evidence that rest breaks together with exercise during the breaks have no effect on musculoskeletal outcomes.  <i>Interventions related to taking regular breaks resulting in less discomfort:</i> <b>Davis and Kotowski (2014)</b> :quasi-experimental study (n=37); <b>Varatharajan et al (2014)</b> : SR found that adding computer-prompted work breaks to ergonomic adjustments and workplace education, benefited workers' recovery from recent work-related neck MSD.

Any of the risk factors listed above may increase or decrease the association between WRUQMP in computer users (Johnston et al 2009). It is therefore necessary to control or monitor risk factors in an intervention study in order to establish that a specific intervention is the reason for an increase or decrease in WRUQMP. Gerr et al (2006) in a review of upper extremity MDSs in computer users, remarked that incomplete control of confounding factors was a severe methodological problem in the literature. Confounding factors which may be important in office workers include psychosocial workplace factors, intensity of computer use as well as time worked at the computer without a break (Andersen et al 2011, Johnston et al 2009, Kaliniene et al 2013).



## **1.4 Ergonomic risk factors associated with WRUQMP in computer users**

Conflicting results have been reported regarding the extent to which various risk factors, inherent in the ergonomic layout of the computer workstation, are most associated with WRUQMP. A review by Cote et al (2009) concluded that a wide range of physical workplace factors, such as sedentary work position, repetitive work and computer workstation setup, were risk factors for neck pain. Individual working techniques and workstation layout, such as the keyboard placed too high and increased neck flexion, were found to be an important consideration in the causality of tension neck syndrome. This was indicated in the findings of a systematic review by Waersted et al (2010) of studies of computer work and musculoskeletal disorders verified by a physical examination. However, the relationship between computer work and neck pain was based on a limited number of studies and this review thus concluded that the evidence for an association between neck pain and computer work is not conclusive. The evidence for the association of sitting posture, VDU and keyboard placement and the interaction of ergonomic and workplace psychosocial factors will now be discussed.

### **1.4.1 Sitting Posture**

Sitting posture is influenced by the dimensions of the computer workstation (Gerr et al 2004a) with prolonged sitting at ergonomically poor workstations shown to be associated with MSD (Aarås et al 1998). The chair influences body alignment (Gerr et al 2004a), consequently a poorly adjusted chair in relation to the worker's anthropometrics and workstation could lead to abnormal strain of the neuromuscular system. This strain may be due to an impaired ability of the postural muscles to support the body (Silverstein et al 2004, Troussier et al 1999). A correctly adjusted chair has been shown to significantly reduce neck pain in seated workers (Rempel et al 2007). Furthermore, a recent systematic review showed that chair interventions have the potential to reduce MSD among workers who are required to sit for prolonged periods (van Niekerk et al 2012). An adjustable office chair may therefore be one possible tool to reduce symptoms of WRUQMP. Interestingly, a recent series of two N=1 studies was conducted whereby an intervention ergonomic chair was compared to a less adjustable, cheaper control ergonomic chair. Both chairs showed

a similar reduction in symptoms, thus indicating almost equivalent benefit from the use of both ergonomic chairs (Hoeben and Louw 2014).

### **1.4.2 Head and neck posture**

Poor neck posture as a consequence to prolonged VDU work, has been shown to be a risk factor for WRUQMP (Bergqvist et al 1995, Gerr et al 2004a, Szeto et al 2002). Specifically, a prolonged forward bent position of the neck has been associated with chronic neck pain in office workers in a study by Cagnie et al (2007). This study used self-report questionnaires to rate exposure to various postures. It has been noted that subjects with neck pain may rate their exposure higher than those without complaints and that this is a limitation in the use of a self-report questionnaire (Ijmker et al 2011). Video analysis to detect posture trends in seated computer workers have demonstrated an increase in forward head posture when working on the computer which is more pronounced in the workers who experience neck MSD (Szeto et al 2002). A trend for a positive relation between neck flexion and neck pain, suggesting an increased risk of neck pain for people working with the neck at a minimum of 20 degrees of flexion for more than 70% of the working time, has been noted. This study was a large prospective cohort study using video analysis of workers with various tasks, including computer based tasks (Ariens et al 2000). More recently, Kaliniene et al (2013) found that a forward neck inclination (>20 degrees) or a neck position which was 'thrown back' was significantly associated with neck MSD in computer users.

### **1.4.3 VDU position**

VDU work may lead to an increase in forward-head posture, which involves a combination of lower cervical flexion, upper or mid cervical extension, and rounded shoulders (Cagnie et al 2007, Szeto et al 2002). Laboratory studies have shown significant increases in activity of the cervical and thoracic extensor muscles with lower VDU placements (Psihogios et al 2001). Furthermore, field studies in the workplace have elicited postures similar to those in laboratory studies (Psihogios et al 2001), also reporting an increased recruitment of the upper trapezius muscle (Straker and Mekhora 2000a). Pain intensity in the neck and shoulder is associated with trapezius loading (Jensen et al 1998). This association is supported by a recent experimental study involving VDU positioning which found a decreased pressure

pain threshold in the upper trapezius even after 30 minutes of VDU work in healthy subjects without neck pain (Shin and Yoo 2013). The top of the monitor in this study was 20 degrees below eye level, however no reference was given for this choice of monitor placement. A limitation of this study was the small number of subjects (n=12), all of whom had no chronic neck pain. Less shoulder pain has previously been reported after an ergonomic intervention which reduced the static EMG trapezius level (Aarås et al 2001), further strengthening the association between increased upper trapezius load and shoulder pain.

Conflicting recommendations to reduce WRUQMP in VDU operators have been suggested (Straker and Mekhora 2000a,b, Bergqvist et al 1995). A monitor positioned lower than eye level, has been purported to both increase (Straker and Mekhora 2000a, Gerr et al 2005a) and decrease WRUQMP (Bergqvist et al 1995). In the study by Straker and Mekhora (2000a), 20 students between the ages of 20 – 30 with no neck/upper back MSD participated in a crossover design study. Subjects worked for a twenty minute period at both a high monitor position (top of the monitor at eye level) and low monitor position (bottom margin of the monitor was at desk level which was set at the subject's sitting elbow height). In this study subjects working with a high monitor position had less head, neck and trunk flexion and less cervical and thoracic erector spinae activity than when they worked with a low monitor position.

The study published by Bergqvist et al (1995) assessed 260 VDU users by means of a questionnaire, physiotherapy examination and workplace ergonomic assessment. The data for the study was collected in 1987. The assessors for each of these study components were blinded to the results of the other examination and questionnaire results. Different to the previous studies, in this study subjects who worked with a VDU at eye level reported intense neck/shoulder discomfort more frequently than those who worked with the VDU placed lower. A limitation of the study was the incomplete information on certain items in each assessment area. Furthermore, this is an older study and technological advances have resulted in marked changes to desktop monitors over the past 20 years. Desktop monitors in recent years are often larger, able to be angled for viewer comfort and the screen itself has advanced with

regard to visual comfort and reduction in glare. This may have contributed to the difference in results regarding VDU placement.

The common recommendation is to place the VDU directly in front of the user with the top of the screen at eye level (Psihogios et al 2001, Szeto et al 2014). The premise is that a raised display reduces head and neck flexion and may therefore reduce WRUQMP (Straker and Mekhora 2000b, Sommerich et al 2001). However, this recommended VDU height may need to be altered according to individual factors, such as the use of bifocal glasses when a slightly lower than eye level position is likely to be more comfortable due to the viewing angle imposed by the glasses (EU and US OSHA guidelines). Sommerich et al (2001) proposed a 'monitor placement strain model' which illustrates the musculoskeletal as well as the visual and individual factors which may be relevant in deciding on the most appropriate VDU position for an individual office worker. Visual factors include glare, accommodation, and discomfort and individual factors include bifocal use and musculoskeletal health. This is in agreement with Straker and Mekhora (2000a) who noted that further research on the compromise between musculoskeletal and visual criteria over prolonged work periods is required before recommendations on a preferred monitor height position can be justified. Consequently, there is unlikely to be a recommended 'one size fits all' VDU placement as factors other than upper quadrant body alignment also play a role.

#### **1.4.4 Keyboard placement**

Korhonen et al (2003) found that poor placement of the keyboard (distance of the keyboard to the edge of the desk of  $< 15$  cm or a deviation of the keyboard from the midline of the body of  $> 2$  cm) increased neck pain. Keyboard placement higher than elbow level has been shown to increase neck pain (Waersted et al 2010) in a review which only included studies in which a physical examination had been performed. Similarly, Gerr et al (2006) noted that placing the keyboard slightly below elbow level showed a reduced risk of neck MSD. Perhaps contrary to popular belief a large prospective cohort study ( $n= 1951$ ) in the Netherlands with a follow up period of two years, reported that supporting the arms during keyboard use was related to an increased risk of neck-shoulder symptoms (Huysmans et al 2012). Notably, keyboard activities, when compared to mouse activities, demonstrated a 50%

increase in the median right trapezius muscle effort in a field study of office workers (n=120) performing their own work for two hours each (Bruno et al 2012). Trapezius loading is associated with pain intensity in the neck and shoulder areas (Jensen et al 1998) and careful attention to keyboard placement is imperative.

#### **1.4.5 Interaction of ergonomic and psychosocial factors**

Johnston et al 2010 investigated how self-reported physical and psychosocial factors in the workplace interact in their effect on neck pain in female office workers and reported greater neck pain when the workstation was described as very uncomfortable. However, workers having a less than optimal monitor height reported less pain when high supervisor support was present. Psychosocial risk factors in the workplace may therefore amplify or reduce symptoms of WRUQMP. Thus psychosocial workplace factors must be considered in studies which aim to determine cause and effect in this multidimensional problem of WRUQMP.

### **1.5 Ergonomic intervention studies relating to WRUQMP in office workers**

Various intervention studies have sought to establish which ergonomic workstation adjustments may be most appropriate to achieve a decrease in WRUQMP (Aarås et al 1998). Often, multiple interventions such as a multifaceted workstation adjustment combined with training in ergonomics, instruction in physical exercises and improvement in the lighting conditions, were implemented simultaneously. The goals of ergonomic training are to improve the computer user's knowledge of office ergonomics, to teach workstation self-assessment, and to enable self-adjustment and rearrangement of the office environment (Esmaeilzadeh et al 2014). This makes the effect of specific components of the ergonomic intervention difficult to assess (Aarås et al. 2001). Keswani et al (2013) found the availability of ergonomic facilities at the workplace to be associated with a lower frequency of neck pain. However in this study the specific ergonomic facilities deemed to have provided the benefit were not reported. It has been suggested that ergonomic interventions should be very clearly defined so that the results of research studies may be clinically useful (Leyshon et al 2010).

Two recent controlled trials (Esmailzadeh et al 2014, Levanon et al 2012) assessed the effect of a multifaceted ergonomic intervention on WRUQMP among computer workers. Esmailzadeh et al (2014) implemented comprehensive ergonomic training in addition to individual workstation adjustments. The study by Levanon et al (2012) additionally included stretching exercises and minibreaks with biofeedback added to one intervention group. Both studies reported a reduction in symptoms in the intervention groups only. No increased benefit was gained from the inclusion of biofeedback (Levanon et al 2012). In both these studies it was not possible to blind the subjects or the assessors; however baseline comparability between groups was good. In the study by Esmailzadeh et al (2014), subjects with WRUQMP were randomly allocated to groups but in the study by Levanon et al (2012) subjects with and without MSD (including the lower back and upper extremity) were allocated to the intervention group if they were the first to arrive at a meeting. The latter allocation procedure may have introduced bias as it is may be argued that those who arrived first for a meeting may be more compliant, or more likely to attempt to please the investigator, during the intervention phase.

The main outcome measure in the study by Esmailzadeh et al (2014) was WRUQMP intensity, measured using a VAPS. The subjects were requested to report symptoms during the previous three months, which is a long recall period and possibly affected accurate symptom report. Levanon et al (2012) used the difference in MSD scores pre- and post-intervention as their primary outcome measure, and subjects were required to indicate only if they had 'no pain' or 'pain'. Therefore a successful result of the intervention would be 'no pain' in that body area. In the presence of chronic or recurring WRUQMP, a complete reduction of pain is unlikely and symptoms tend to fluctuate over time. The one pre and post intervention measure, as in the study by Levanon et al (2012), provides information at that point in time but does not establish a trend as to the effect of the intervention over a period of time.

A strength of the studies by Esmailzadeh et al (2014) and Levanon et al (2012), is that these studies included self-report and objective workstation posture assessments respectively, at entry and exit of the study. Both studies reported improvement in workstation posture, mirroring the reduction in WRUQMP.

Esmaeilzadeh et al (2014) viewed the use of self-report posture assessment to be a limitation of their study as this subjective tool may introduce bias and recommended that an objective measure would be preferable. Therefore an objective account of sitting posture is a superior method of postural examination compared to subjective or self-report measures as it can provide information about the biomechanical alignment of the bony structures at any specific moment in time (Brink and Louw 2013). Earlier studies implementing specific ergonomic interventions have had positive results. Mekhora (1999) performed a randomised controlled trial (RCT) to assess the effect of an ergonomic intervention on WRUQMP. The allocation of subjects to groups was random but not concealed and subjects and assessors were not blinded. The workstation intervention was by means of a computer software application (Nanthavanij and Venezia 1999) and simple materials were used to adjust multiple components of the computer workstation according to the individual anthropometry of the symptomatic office workers (n=80). VDU, seat and keyboard heights were adjusted and foot stool and document holders provided. A Visual Analogue Pain Scale (VAPS) was used to rate subjects' discomfort in the early afternoon. A strength of this study was the additional use of a "recalled discomfort" rating on rising in the morning of the same day. This was obtained to determine whether the 'recalled discomfort' could have influenced the validity of the discomfort rating in the afternoon. Poor baseline comparability between groups was a further limitation of the study.

The discomfort ratings of multiple areas reduced after this intervention even though the intervention was aimed at WRUQMP. The authors commented that changing the work station posture may affect multiple anatomical regions. Additionally, the placebo effect may have occurred as subjects might have assumed the intervention to be a superior workstation and this may have affected the outcome. This study did not assess the extent of the mismatch in the workers' workstation settings as compared to the recommended settings prior to adjustment. Additionally, workload and work duration were significantly different within the subject group during the intervention period which may have resulted in a change in discomfort level. The researchers suggested that future studies should include data relating to workload

variables at subject selection. This study was deemed to be of low quality in a review by Boocock et al (2007).

Hochanadel (1995) performed a large study (n=531 at follow up) in which specific workstation height adjustments (see table 3), relating the computer user to the existing furniture, were implemented. Workstation adjustment measures were generated by a computer program and the adjustments were made by the study subjects themselves. The most common anthropometric mismatch was chair height, followed by VDU height. Eighty percent of those making the recommended workstation adjustments indicated benefits through enhanced work efficiency and comfort. This study allows a practical approach as desk height was chosen as the reference point from which height changes were subsequently made. This is achievable for the majority of workers with an adjustable chair height (Hochanadel 1995).

A clinically interesting ergonomic intervention case study of a patient presenting with neck pain exacerbated by work, was reported by Fabrizio (2009). Four weeks of traditional physiotherapy were followed by a multidimensional ergonomic intervention. This intervention included multiple workstation adjustments including the installation of new workstation equipment as well as patient education and exercise. The patient's "present level of pain" rating on the VAPS decreased by 1.0 cm following the four weeks of traditional physiotherapy and decreased by an additional 3.6 cm following the ergonomic intervention period. An interesting observation made in this study was that the ergonomic adjustment was much more cost effective than the intensive physiotherapy treatment, and achieved a greater decrease in symptoms.

Conversely, Gerr et al (2005) in an earlier RCT concluded that the two ergonomic interventions implemented were unlikely to reduce the risk of WRUQMP in computer users. Again it was not possible to blind the subjects or assessors and although subject allocation to groups was random, it was not concealed. The interventions included a postural workstation adjustment to allow for a neck position close to neutral and a keyboard position of either lower than elbow height (alternate intervention) or slightly higher than elbow height (conventional intervention). In addition, arm, wrist and mouse adjustments were introduced and an adjustable chair



provided as needed. The authors acknowledged that in this study the workstation could not always be modified according to the guidelines and poor compliance possibly affected the results of the study. Fewer than one third of one group and one half of the other intervention group participants were fully compliant with the interventions (Gerr et al 2005).

Reviews examining the effect of ergonomic workstation interventions have yielded mixed results. Brewer (2006) reported moderate evidence that a workstation adjustment has no effect on MSD. Boocock (2007) reported 'some evidence' for workplace ergonomic adjustments and 'moderate evidence' for a change in equipment, such as keyboard design, as having an effect on MSD. The difference in results reported in the two reviews may be due to different methods used to search for and rate the quality of the articles as there were no overlapping articles, with articles included from 2001 – 2005 (Brewer et al 2006) and 1999 – 2003. (Boocock et al 2007). These two review articles demonstrate that no strong evidence was available at this time for specific workstation interventions.

A later review again found no single ergonomic intervention to be strongly supported by the literature due to the low quality of evidence, and recommended further research to support the viability of ergonomic interventions in office workers who do have MSD (Leyshon et al 2010). However, Leyshon et al (2010) did report moderate evidence for forearm support to significantly reduce WRUQMP and for an intervention of ergonomic workstation redesign to improve comfort. The body area for this latter outcome of 'comfort' was not specified as it varied in the studies included. Similarly, Andersen et al (2011) performed a review of systematic reviews of ergonomic interventions published between 1999 and 2010 and concluded that no effective interventions have yet been documented. The authors considered reasons for this uncertainty to include the mixed outcomes yielded by ergonomic intervention studies (Andersen et al 2011). The literature reviewed above suggests that the evidence supporting the value of ergonomic intervention in WRUQMP is currently inadequate for strong recommendations to be made to financial or legislative stakeholders (Waersted et al 2010).

## 1.6 The proposed biological mechanism underlying WRUQMP

WRUQMP symptoms, related to computer use, are commonly described as a low level ache, pain or discomfort (Paksaichol et al 2012b, Punnett and Bergqvist 1997). The forward head posture, noted to be common in office workers who are computer users, (Cagnie et al 2007) may result in increased cervical spine compressive loading and a creep response in the tissues (Harms-Ringdahl et al 1986). This biological response may occur concurrently with increased electromyographic activity in the cervical musculature (Szeto et al 2002). Laboratory and field studies have shown significant increases in activity of the cervical and thoracic extensor and upper trapezius muscles with lower VDU placements and higher keyboard placements (Faucett and Rempel 1994, Psihogios et al 2001, Straker and Mekhora 2000a). Looking up to a VDU will increase upper cervical extension which may cause increased load on deep sub-occipital muscles (Burgess-Limerick, 2000).

Trapezius load is associated with pain intensity in the neck and shoulder areas (Jensen et al 1998). It has been hypothesised that the physiological consequences of continuous muscle contraction and resultant localized muscle fatigue, may result in neck and shoulder myofascial pain in VDU workers (Visser 2006). Muscles causing chronic pain differ in their activation and relaxation patterns (Hermens and Hutten 2002), and insufficient muscle relaxation of low threshold motor units has been related to MSD, specifically chronic pain in the upper trapezius (Hagberg et al 1995). Myofascial trigger points have been shown to develop after one hour of continuous typing, despite the stress condition (Hoyle et al 2011). Furthermore, lower pressure pain thresholds in the upper trapezius have been demonstrated after as little as 30 minutes of computer work in healthy subjects (Shin and Yoo 2013).

The postural demands placed on the office worker may therefore play a role in his/her muscle activation patterns. The change in posture associated with computer use may thus contribute to the elevated risk of neck MSD in office workers (Straker et al 2008). Similarly, a change in the worker - workstation interface changes the demand on the worker's body, and subsequently his/her posture in response to this changed demand (Mekhora et al 2000).

## 1.7 Recommendations for ergonomic adjustment

WRUQMP is a large and growing problem and therefore many recommendations have been developed in an attempt to reduce the risk of MSDs in VDU operators (Straker and Mekhora 2000a). Table 1.3 summarises some examples of these recommendations pertaining to VDU and keyboard height placement. Preferred height placements may vary with different job related task demands as well as with the computer user's individual musculoskeletal and visual system features (Straker and Mekhora 2000b, Sommerich et al 2001). This may explain the success of personalised ergonomic workstation adjustments by trained therapists (Esmailzadeh et al 2014, Levanon et al 2012, Pillastrini et al 2007).

**Table 1.3: Examples of recommendations for monitor and keyboard placement**

Monitor and/or keyboard height	Recommended
Place the VDU directly in front of the user with the top of the screen at eye level	Psihogios et al (2001), Szeto et al (2014).
Place the keyboard below elbow height	Gerr et al (2006)
Keyboard height such that the shoulders are relaxed and the elbows are about the same height as the keyboard. Top of the monitor is recommended to be at or slightly below eye level. Bifocal users are recommended to lower the monitor below levels for non-bifocal users.	EU and US OSHA  <a href="https://www.osha.gov/SLTC/computerworkstation/index.html">https://www.osha.gov/SLTC/computerworkstation/index.html</a>
Keyboard height which facilitates relaxation of the shoulders and a slightly open position at the elbow joints (100 – 110 degrees). Top of the monitor is suggested to be 5 – 7.5 cm above eye level	South African Society of Physiotherapy  <a href="http://www.physiosa.org.za/?q=node/97">http://www.physiosa.org.za/?q=node/97</a> , 2005
Keyboard height to allow forearms to be parallel to the floor. Top of the monitor at eye level.	Hochanadel (1995)

## 1.8. Relevant outcomes to be measured

### 1.8.1 WRUQMP

WRUQMP symptoms, related to computer use, are commonly described as a low level ache, pain or discomfort (Paksaichol et al 2012a, Punnett and Bergqvist 1997). The Visual Analogue Scale (VAS), a self-report instrument, has been used in observational and intervention ergonomic studies to measure the subjective outcome of pain (Esmailzadeh et al 2014, Gerr et al 2005a, Mekhora et al. 2000). In

comparison with discrete scales, measurement by a VAS is more exact, and the scale needs less explanation for the research participants (Reips and Funke 2008). Validity has been demonstrated with a correlation coefficient of 0.95 when compared to the McGill Pain Questionnaire and the Numeric Pain Scale (Ferraz et al 1990). Test re-test reliability was established at 0.71 - 0.99 (Ferraz et al 1990).

### **1.8.2 Work related sitting comfort**

Comfort has been defined as a pleasant state or relaxed feeling of a human in reaction to its environment' and discomfort as 'an unpleasant state of the human body in reaction to its physical environment' (Vink and Hallbeck 2012). Corlett and Bishop (1976) considered work-related comfort as a concept with a threshold level above which the operator would not be distracted from his work. The overall level of comfort was understood to be the sum of all the individual sensations, including the environment and the worker-workstation interface. A change in pain intensity in a specific body part thus need not correlate to a change in perceived comfort.

The relationship between self-reported discomfort and musculoskeletal injuries has been proposed (Hamberg-van Reenen et al 2008). Poor perceived comfort has been shown to be an early indicator of WRUQMP in computer users, and thus 'comfort' may be an important outcome measure to identify individuals at risk of developing chronic MSD (Wahlstrom et al 2004). Similarly, Lindegaard et al (2012) assessed perceived comfort by means of a 9 point questionnaire ranging from -4 (very, very poor) to +4 (very, very good) and concluded that low perceived comfort should be regarded as a risk factor for future neck and upper extremity symptoms.

Furthermore, reduced productivity has been reported due to neck and upper extremity symptoms and it has been suggested that making operators more comfortable is something that firms cannot afford not to do (Corlett and Bishop 1976). Zenk et al (2012) have suggested that for low physical load levels (< 65% MVC), comfort scales are more useful than discomfort scales. They further reported that at low load levels, subjects are able to feel differences which relate to objective findings.

Previous studies have used a VAS or questionnaires to measure comfort (Gerr et al 2005a, Lindegard et al 2012a, Mekhora et al 2000). However, as comfort is arguably a less often investigated construct compared to outcomes such as pain, further research may be required to establish standardised methods to measure comfort.

## **1.9 Significance of this study**

There is significant heterogeneity regarding ergonomic interventions tested and outcomes measured in the literature in relation to WRUQMP (Andersen et al 2011). Furthermore, the term 'workstation adjustment' has been used very broadly and workstation interventions have frequently been compared to ergonomic training (Brewer et al 2006). WRUQMP in computer users is a multidimensional problem, which must ultimately be addressed by a multidimensional intervention (Esmaeilzadeh et al 2014). Additionally, risk factors interact with the combined effect being different (enhancing or buffering) to the sum of the individual effects. However multifaceted ergonomic interventions make it difficult to accurately determine the relative attributable contribution of a specific intervention. It has been suggested that ergonomic interventions should be very clearly defined so that the results of research studies may be clinically useful (Leyshon et al 2010). Moreover, stronger research evidence would assist employers and legislators to understand the relative significance of specific ergonomic interventions (Waersted et al 2010).

Compliance with postural and ergonomic advice requires active participation from the computer user, who may be distracted by the workload at hand. Furthermore the need for training time and resources adds to the expense of the intervention.

This study therefore poses the following question: Does a simple vertical adjustment of the chair and VDU height, without confounding treatment or advice, have an effect on WRUQMP and sitting comfort in office workers? This practical intervention, not identified to our knowledge in the literature to date, would be economical and easy to implement and enable self-management for the office worker suffering from WRUQMP.

## **1.10 Study aim**

The aim of this study is to assess the effect of adjusting the workstation chair and VDU height on WRUQMP and sitting comfort in computer users. The premise is that the change in worker-workstation interface will allow a change in workstation posture and subsequently a change in the demands on the musculoskeletal system of the worker.

This thesis will follow a publication format as per the faculty's guidelines.

## CHAPTER 2: JOURNAL ARTICLE

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### 2.1 Abstract

**Aims:** To assess the effect of a vertical height adjustment of the chair and visual display unit (VDU) on work related upper quadrant musculoskeletal pain (WRUQMP) and sitting comfort in computer users.

The upper quadrant refers to the occiput, cervical and upper thoracic spine including the clavicles and scapulae.

**Methods:** An N=1 study was conducted using the ABC design whereby an ergonomic workstation adjustment, of VDU and chair height, was compared to the subject's usual workstation settings. Pain and sitting comfort were measured using visual analogue scales (VAS). The subject was assessed over the four week phases as she performed her typical VDU work. The results were compiled and tabulated.

**Results:** Both the mean and variance in pain intensity decreased after the workstation intervention. A deterioration was noted in sitting comfort.

**Conclusion:** The vertical height adjustment of the chair and VDU may have contributed to a decrease in WRUQMP in this subject. This safe, economical workstation intervention may be a practical management option for the computer user suffering from WRUQMP. Further research into the measurement of comfort whilst sitting at a computer workstation, is recommended.

### 2.2 Introduction

Prolonged computer use has become customary in present-day office work environments (Wahlstrom et al 2004). An associated increase in work related upper quadrant musculoskeletal pain (WRUQMP), especially among those who are intensive computer users is also evident (Cagnie et al 2007, Jensen 2003, Paksaichol et al 2012a, Pillastrini and Mugnai 2010). The upper quadrant refers to the occiput, cervical and upper thoracic spine including the clavicles and scapulae (Brink and Louw 2013). This increase in WRUQMP in computer users is of individual as well as economic concern (Waersted et al 2010), with notable economic cost



implications due to absenteeism, decreased productivity and health care expenditure (Heinrich et al 2004). The neck is one of the most susceptible areas for musculoskeletal disorders (MSD) in computer users, (Cagnie et al 2007, Jensen 2003,) with prevalence rates of 65% - 75% reported (Cho et al 2012, Griffiths et al 2012, Kaliniene et al 2013, Tornqvist et al 2009).

Of concern is that prevalence rates have not decreased over the past three decades, despite efforts in the workplace. These workplace interventions are further complicated due to the multidimensional nature of the problem, with non-modifiable and modifiable risk factors applicable (Johnston et al 2009). Non-modifiable risk factors include higher age (older than 30 years) (Cagnie et al 2007), female gender (Evans and Patterson 2000, Paksachol et al 2012b, Waersted et al 2010) and a previous history of neck pain (Paksachol et al 2012a). Modifiable risk factors include the physical office environment, psychosocial workplace factors and workstation postural factors (Aarås et al 1998), the latter being the focus of this study. Furthermore physical and psychosocial factors in the workplace have been shown to interact in their effect on neck pain (Johnston et al 2009) with high supervisor support shown to buffer physical risk factors such as increased time spent on computer tasks and an incorrectly positioned VDU (Johnston et al 2009).

Numerous studies have undertaken to identify which factors inherent in the workstation layout, are most associated with WRUQMP (Andersen et al 2011). Prolonged sitting at ergonomically poor workstations has been associated with MSD (Aarås et al 1998). The chair influences the position of the computer user in relation to his/her keyboard and VDU and consequently, the body alignment demands on the worker (Gerr et al 2004b). A correctly adjusted chair has been shown to significantly reduce neck pain in seated workers (Rempel et al 2007) with a recent review demonstrating that chair interventions have the potential to reduce MSD among workers who are required to sit for prolonged periods (van Niekerk et al 2012). Similarly, VDU and keyboard height in relation to the computer user, have been investigated (Gerr et al 2006, Straker and Mekhora 2000a). VDU height has been shown to affect neck alignment, with prolonged neck postures in which the neck is 'bent forwards' or 'thrown back', associated with neck MSD in computer users (Cagnie et al 2007, Kaliniene et al 2013, Pillastrini and Mugnai 2010, Psihogios et al

2001, Straker and Mekhora 2000a). Likewise, higher keyboard placements have been associated with increased stiffness in the upper trapezius muscle (Faucett and Rempel 1994), consistent with findings that keyboard placement at or slightly below elbow level reduces the risk of neck MSD (Gerr, et al 2006, Waersted et al 2010). Thus, the body alignment required from the office worker, when working at an inadequately adjusted computer workstation, may contribute to an elevated risk of WRUQMP (Straker et al 2008).

However, the causal relationship of the computer workstation posture and MSD has been questioned (Andersen et al 2011, Brewer et al 2006, Boocock, et al 2007). Reasons for this uncertainty include the mixed outcomes yielded by ergonomic intervention studies (Andersen et al 2011) and multifaceted interventions which preclude distinct deductions relating to workstation adjustments and WRUQMP (Esmaeilzadeh, et al 2014). Additionally, the incomplete control of known confounding factors, such as workplace psychosocial factors and ergonomic advice, has been a severe methodological problem in the literature (Gerr et al. 2006). A review by Leyshon et al (2010) did report moderate evidence that ergonomic workstation redesign improves comfort, however no single ergonomic intervention was strongly supported. Recent randomised controlled trials (RCTs) have reported a reduction in WRUQMP following chair and VDU height adjustments in the intervention groups only (Esmaeilzadeh et al 2014, Levanon et al 2012). However, these studies included multiple ergonomic changes such as ergonomic training, stretching exercises and minibreaks, making it difficult to determine the effect of the workstation adjustment alone. In contrast, a RCT conducted by Gerr et al (2005), concluded that adjusting the workstation chair and VDU height, with additional wrist and mouse positional adjustments, was unlikely to reduce the risk of WRUQMP in computer users.

Clinical advice, workplace policies as well as government legislative policies need to be based on trustworthy scientific guidance (Waersted et al 2010). However, a strong level of evidence is still not available to support the viability of specific ergonomic interventions in WRUQMP in computer users (Andersen et al 2011). Further research is thus needed, with clearly defined results (Leyshon et al 2010)

and adequate control of confounding factors (Gerr et al 2006), to be useful to professionals working directly with WRUQMP (Leyshon et al 2010).

A simple vertical adjustment of only the chair and VDU height, without confounding advice or other treatment, has not been identified in the literature reviewed to date. This practical intervention would be economical and easy to implement, facilitating self-management for the office worker suffering from WRUQMP. Training time and resources add to the expense of an intervention and compliance with postural and ergonomic advice requires active participation from the computer user, who often is distracted by the workload at hand. Therefore, an intervention which does not require any participation from the worker beyond an initial basic chair and /or VDU height adjustment is appealing.

This study was done to ascertain whether adjusting only the vertical height of the chair and VDU in relation to the computer user, would affect his/her WRUQMP. The hypothesis is that symptoms of WRUQMP would be reduced following this ergonomic intervention. The basis for this intervention is that a change in the worker-workstation interface alters the postural demand placed on the worker, and subsequently the demand on his/her musculoskeletal system.

## **2.3 Methodology**

### **2.3.1 Study design**

A single subject N=1 experimental series type ABC, with four weeks per phase, was conducted. It was hypothesised that an adjustment of the chair and computer screen height would reduce the subject's WRUQMP and improve sitting comfort.

### **2.3.2 Subject description**

Subjects were eligible if they were office workers who used a computer for at least five hours per day and experienced neck and/or upper back symptoms associated with computer use that had been persistent or recurrent over the past three months. Additionally, the workstation of eligible participants had a seat and /or VDU height that was not within 10% of the seat and VDU height recommended in the literature (Hochanadel 1995).

Potential participants were excluded from the study if they had neurological or other pathology, or had previous cervical or upper thoracic surgery/ trauma that may contribute to the neck and upper back pain.

Furthermore, potential participants were excluded if they were undergoing treatment for neck or upper back pain as this may modify their pain/comfort. Additionally, respondents who had a BMI score of greater than 30, were pregnant, were smokers or used bifocal glasses were excluded as these factors influence body anthropometry and/or musculoskeletal discomfort (Doll et al 2000, Borg-Stein et al 2005, Brage and Bjerkedal 1996). A screening questionnaire was used to identify eligible subjects (Addendum 6 and 7).

### **2.3.3 Study procedures**

- **Recruitment**

The study population, office workers in the administration department of Constantiaberg Mediclinic, was selected due to its proximity to the researcher's own workplace. A letter was sent to the human resources department at Constantiaberg Mediclinic requesting permission to conduct the study. Permission was granted on the 4th September 2013. All the office workers in the administration department who were at work that week completed a screening questionnaire, which included the inclusion and exclusion criteria for the study, in order to identify eligible subjects.

- **Study phases**

During phase A, the baseline phase, no change was made to the workstation. Phase B was the intervention phase and the workstation (chair and VDU height) was then adjusted as shown in Table 2.1 (Hochanadel 1995). The desk height was chosen as the fixed reference point from which the chair height and VDU height adjustments were calculated (Hochanadel 1995).

**Table 2.1: Recommended workstation measurements (Hochanadel 1995).**

Elbow height	desk height to floor + 25mm
Elbow to seat distance	olecranon (with the subjects' upper arm relaxed at their side, and the elbow flexed to 90') to the seat.
Eye to seat distance	corner of the subject's eye to the seat
Intervention seat height	'elbow height' - 'elbow to seat' distance
Intervention VDU height	'seat height' + 'eye to seat' distance
Foot rest	The participant already had an adequate footrest which she was encouraged to use once her chair height was altered to allow her feet to rest on a firm surface.

No further ergonomic intervention or education was offered and the subject continued with her usual work for four weeks. At the start of phase C, the subject was informed that she was now free to change her workstation parameters, should she choose to do so.

- **Outcome measures and measurement time-frames**

The primary outcome was neck and upper back pain intensity and the secondary outcome was comfort level while sitting at work. Each outcome was measured twice a week, at the end of the workday on a Tuesday and Thursday, with a Visual Analogue Pain Scale (VAPS) and Visual Analogue Discomfort Scale (VADS), as shown in Table 2.2 and Figure 2.1. The subject posted the completed forms into a sealed box which was provided by the researcher and kept at the subject's workstation.

**Table 2.2: Measurement time frames**

Study Phase	Measurements per week	Measurements per phase
A	2 VAPS	8
	2 VADS	8
B	2 VAPS	8
	2 VADS	8
C	2 VAPS	8
	2 VADS	8

**VAPS**

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

**VADS**

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

**Figure 2.1: VAPS and VADS**

The VAS is a self-report instrument consisting of a 100mm horizontal line, which the subject was asked to complete by making a mark on the relevant line to indicate her pain intensity and comfort, during the previous two working days.

In comparison with discrete scales, measurement by a VAS is more exact, and the scale needs less explanation for the research participants (Reips and Funke 2008). Validity has been demonstrated with a correlation coefficient of 0.95 when compared

to the McGill Pain Questionnaire and the Numeric Pain Scale (Ferraz et al 1990). Test re-test reliability was established at 0.71 - 0.99 (Ferraz et al 1990). The researcher measured the distance from the 'no pain' and 'very comfortable' anchor labels to the point marked by the subject.

- **Measurement of potential known confounding factors**

Known confounding factors were monitored at various stages of the study as follows:

**At entry to the study:** The eligible subject was interviewed and examined by the researcher according to neuromusculoskeletal principles (Petty 2011). This assessment provided information relating to the following: co-morbidities, psychosocial workplace factors, the nature of the job, frequency of breaks during the day, frequency of physical activity during the week, the physical work environment, mattress, pillow or wearing of prescription glasses; as well as an open question regarding any other factors the subject may presume to be related to her WRUQMP. The 5 item Keele Generic Tool was included at the time of entry and exit from the study as psychosocial factors significantly affect pain intensity (Miles et al 2011) and a change in psychosocial factors within the study period may therefore have introduced a confounding factor into the study. This is the psychosocial subscale of the STarT Back Tool, modified to screen/identify distress in conditions other than lower back pain. The Keele 5 item STarT generic screening tool was developed by Hill et al (2008). The Chronbach's alpha was 0.74 for this five psychosocial item subscale and substantial 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 and upper back pain.

**At exit of the study:** At the end of phase C the subject completed an exit questionnaire to assess any change in these known confounding factors, as mentioned above at time of entry to the study, to allow the researcher to consider these factors when interpreting the data.

**Twice weekly throughout the study:** The subject indicated if she had taken any medication for her neck or upper back pain over the previous two working days, each time she completed the VAPS and VADS. This was necessary to establish whether the use of analgesia had affected the pain and comfort level reported.

**At the end of each phase:** The subject completed a questionnaire at the end of phases A and B, in which she reported the following: if she had received any treatment for her neck or upper back, altered the workstation herself or if there were



any other factors over the past four weeks which may have influenced her work related symptoms.

At the end of Phase C, the Exit Questionnaire included these Phase End questions.

A brief exit interview was performed to assess the subject's overall experience of the study, and specifically her understanding of the VADS. This exit interview was performed in an attempt to understand the discrepancy in the subject's verbal comments to the researcher, reporting on the VAPS and reporting on the VADS.

### **2.3.4 Data analysis**

All data was captured on a Microsoft Excel 2010 spread sheet and descriptive statistics were used to describe the data set. As a measure of central tendency the mean was calculated and the range was calculated as a measure of variability for each phase, for the outcomes of pain and comfort. Measurements for A6 were not possible as the subject was absent that Thursday. The 2SD band method could not be used for the outcome of pain as the variance resulted in a negative -2SD value, which is not plausible for a VAPS as its lowest value is 0. The effect sizes for pain and comfort were calculated. Line graphs were drawn using Microsoft Excel 2010 to depict the trend for the outcome measures of pain and comfort.

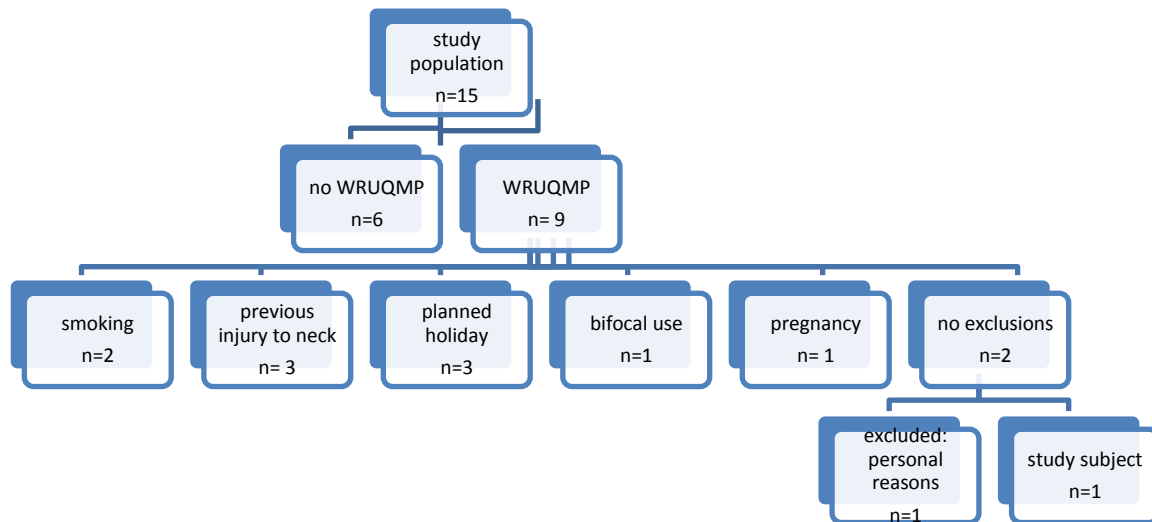
### **2.3.5 Ethical considerations**

Approval for the study was obtained from the Committee of Human Research at Stellenbosch. The participant signed informed consent.

## **2.4 Results**

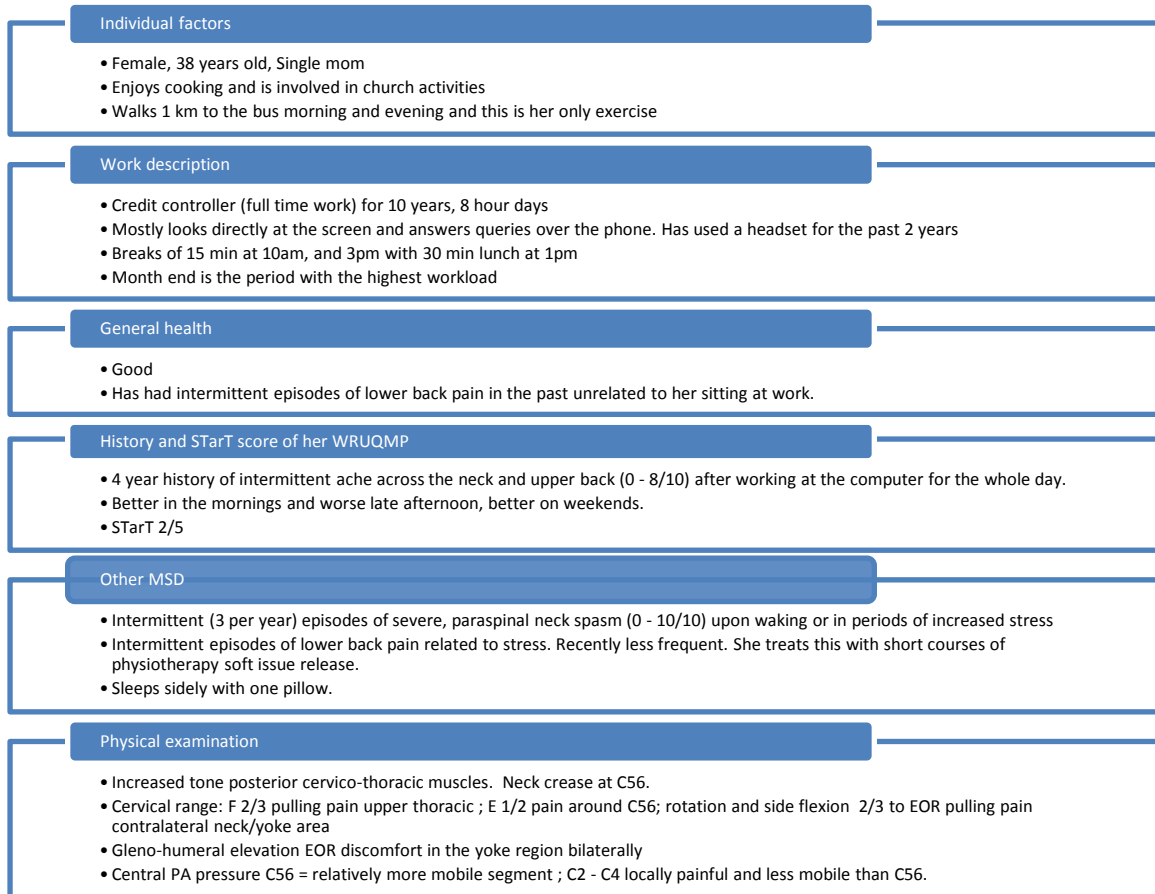
### **2.4.1 Study population and subject description**

Fifteen office workers completed the screening questionnaire, with figure 2.2 showing how the subject for the study was recruited. Some potential participants were excluded from the study due to more than one reason.



**Figure 2.2: Flow chart of the recruitment process**

Figure 2.3 shows the interview and physical examination information gained for the study subject and Table 2.3 lists her baseline workstation measurements (Phase A) and the measurements used to adjust the workstation for the intervention (Phase B).



**Figure 2.3: Subject interview and physical examination**

**Table 2.3: Subject workstation measurements**

Workstation variable	Chair	VDU
Usual height	470mm	1360mm
Adjusted height	515mm	1235mm
Mismatch	45mm = 9.6% ( <i>chair too low</i> )	125mm = 9.2% ( <i>VDU too high</i> )

The photographs in figure 2.4 show that although the chair and VDU height mismatches were between 9 - 10 %, the difference in the pre and post intervention VDU height was relatively greater. This was due to the pre-intervention height relationship in which the VDU was too high in addition to the chair position being too low.

**Figure 2.4: Photographs of the subject's workstation (before and after workstation adjustment)**

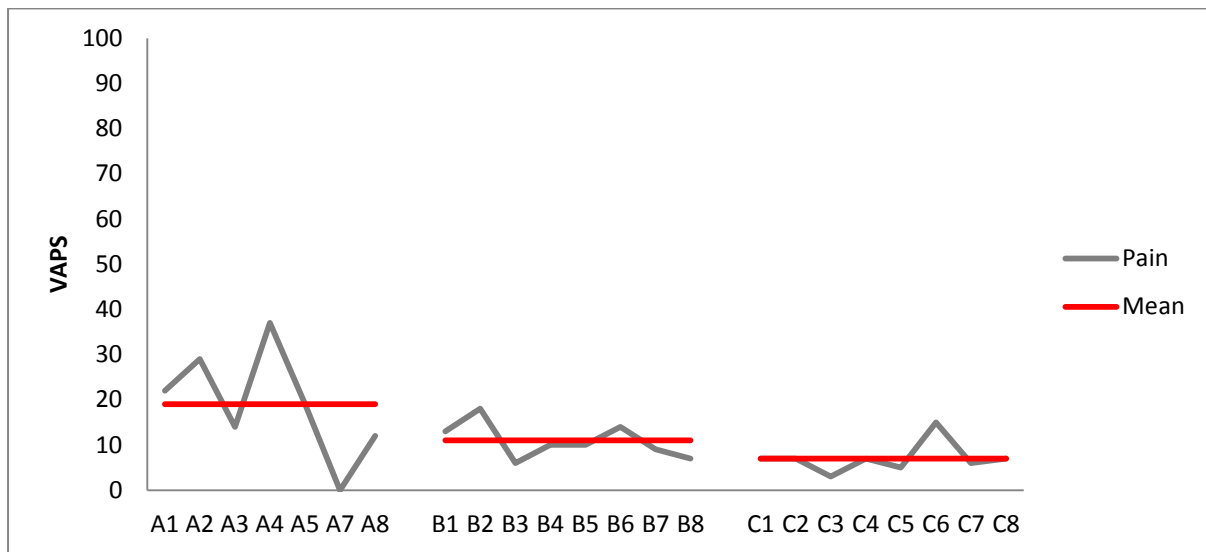


The subject chose not to adjust her workstation during phase C, preferring to keep it at the phase B intervention adjustment heights.

## 2.4.2 Outcome measures

- **Pain intensity**

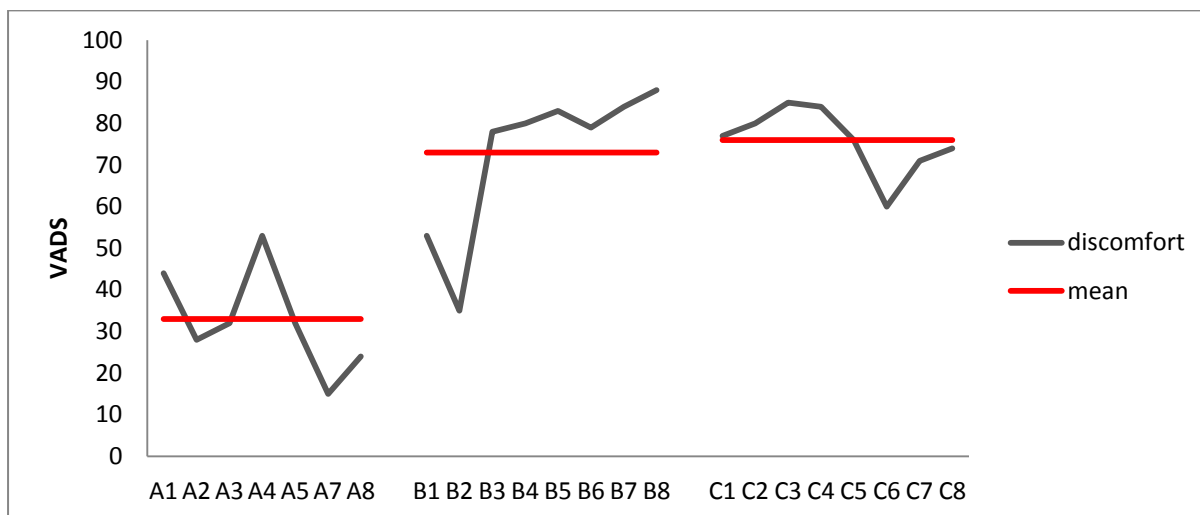
Figure 2.5 shows the trend for pain intensity over the three study phases and the mean value for each phase. The mean pain level decreased from phase A to phase C. The effect size for pain intensity from phase A to phase B was 0.67 and the effect size from phase A to Phase C was 1.0. This shows a small yet durable effect, which was maintained from phase B to phase C.



**Figure 2.5: VAPS measurements with the mean for each phase**

- **Comfort level while sitting at work**

Figure 2.6 shows the trend for comfort level while sitting at work over the three study phases, and the mean value for each phase. Higher VADS scores were obtained in phases B and C, with corresponding higher mean values for discomfort in these phases. The effect size for comfort level while sitting at work from phase A to phase B was 3.17 and the effect size from phase A to phase C was 3.4. This shows a medium effect for an increase in *discomfort* which was maintained from phase B to phase C.



**Figure 2.6: VADS measurements with the mean for each phase**

Table 2.4 shows the means and ranges for all phases for the outcomes of pain and comfort. The mean for pain reduced by 12 mm from phase A to phase C. The variability of pain as indicated by the range (min - max) also reduced from 37 in Phase A to 12 in Phase C. The trend for the data for comfort shows an increase in the mean discomfort scores of 43mm from phase A to phase C. The variability of discomfort as indicated by the range (min-max) increases initially in phase B before decreasing in phase C.

**Table 2.4: Means and ranges per phase for the outcomes of pain and comfort**

		Phase A	Phase B	Phase C
Pain Intensity	Mean (Min-Max)	19 (0-37)	11 (6-18)	7 (3-15)
	Range	37	12	12
Discomfort	Mean (Min-Max)	33 (15-53)	73 (35-88)	76 (60-85)
	Range	38	53	25

### 2.4.3 End of phase and end of study (exit) questionnaires

- **End of phase**

Table 2.5 shows the known confounding factors assessed at the end of each study phase. These factors were constant over the three month study period.

**Table 2.5: Assessment of known confounders (End of Phase)**

Confounding variable	Phase 1	Phase 2	Phase 3
Absent	Yes, 1 day	Yes, 1 day	No
Other treatment received	No	No	No
Own workstation adjustments	No	No	No
Open question: Anything else relevant	No	No	No
<i>Pain medication used for neck or upper back</i>	<i>No</i>	<i>No</i>	<i>No</i>

- **End of study (exit)**

Table 2.6 shows the known confounding factors assessed at the time of exit of the study and compared to these factors at entry to the study. These factors were constant over the three month study period.

**Table 2.6: Assessment of known confounders (End of Phase C and relating to the previous 3 months)**

Confounding variable	Subject's response
Change in the nature of the work	No
Change in physical work environment	No
Change in exercise frequency	No
Change in family and social life	Grandfather died day after measurement C4
Accidents or injuries	No
Changes in general health	No
Change in mattress or pillow	No
Change in glasses prescription	No
STarT Generic Screening Tool	Study entry: 2/5 (low); Study exit: 0/5 (low)

- **Exit interview**

The researcher briefly interviewed the subject regarding her overall experience of the study one week after completion of the study data collection. The subject verbally reported to be 'much more comfortable' after the intervention and was surprised that her VADS (figure 2.1) scores had reflected that she was more uncomfortable. She indicated that she could have misunderstood the VADS. Furthermore, she reported that her intermittent familiar lower back muscle tightness had increased over the previous few days.

## **2.5 Discussion**

Work related upper quadrant musculoskeletal pain (WRUQMP) is a common problem in office workers who use computers (Cagnie et al 2007), with prevalence rates of 65 -75% reported (Cho et al 2012, Griffiths et al 2012, Kaliniene et al 2013, Tornqvist et al 2009). Ergonomic intervention studies aimed at reducing WRUQMP have yielded mixed outcomes (Andersen et al 2011). Thus uncertainty exists amongst clinicians as to which workstation adjustments to recommend. The finding in this study suggests that a chair and computer screen height adjustment may reduce WRUQMP in computer users.

In our study, the trend for WRUQMP intensity decreased after the intervention was introduced (see Figure 2.5). The subject was a thirty-eight year old full time female office worker, who uses a computer for most of her eight hour work day. The subject's mean pain level decreased by 12 mm during Phase C compared to the baseline level in Phase A. This decrease in pain is less than the 20 mm required to be a MCID in chronic pain (Ostelo et al 2008). Thus, although the mean pain decreased by half of the mean intensity of pain during the baseline phase, it is uncertain whether the change was meaningful to the subject. In the future, it is suggested that the patients' perception of what would constitute a clinically meaningful change should be assessed before commencement of the study. The variability of pain decreased during the intervention and last phases. The reduced variability from Phase A indicated a positive effect of the intervention, since more stability in symptoms was noted during the latter two phases. Since the pain did not increase during the period of increased workload at month end, it affirms the



improvement in her symptoms. The ergonomic intervention may thus have had a buffering effect on the pain intensity during periods of increased workload. Our findings pertaining to pain intensity and variability of pain are consistent with ergonomic workstation intervention studies which have reported a decrease in WRUQMP (Esmailzadeh et al 2014, Levanon et al 2012, Hochanadel 1995, Mekhora et al 2000).

Esmailzadeh et al (2014) also investigated subjects who had symptoms of WRUQMP and used a VAPS for the outcome measure of pain intensity. The subjects in their study were requested to report symptoms during the previous 3 months. Our outcome measures were assessed more frequently with a symptom recall period of only two days, possibly enabling more accurate symptom report. Furthermore, the study by Esmailzadeh et al (2014) included comprehensive ergonomic training as well as workstation adjustment. This training consisted of two theoretical and practical interactive ergonomic lessons, each ninety minutes long, conducted by the investigators who were qualified in ergonomic training. In addition, participants in the intervention group received an ergonomic training brochure which consisted of information about office ergonomics such as risk factors for WRUQMP, importance of prevention, workstation adjustments, and workplace exercises. Participants were taught how to adjust their individual workstations and checked and encouraged to do so at monthly intervals. Similarly Levanon et al (2012) included a comprehensive individual worksite adjustment (up to 6 weekly sessions with all equipment adjusted relevant to the workers anthropometrics), corrective exercise (for specific MSDs, muscle relaxation, and including a home program to be repeated twice daily) and minibreaks (brief muscle relaxation at the workstation and breaks of minutes accompanied by a computer announcement). A reduction of the WRUQMP scores in the intervention groups only was reported. In the studies by Esmailzadeh et al (2014) and Levanon et al (2012), it is thus the combination ergonomic intervention which is suggested to reduce the WRUQMP, not the effect of the workstation height adjustment alone. However, the combined intervention does not enable the researchers to discern which aspect of the intervention was associated with the decreased pain reported. Hence, our study only focussed on vertical adjustment alone to ascertain whether it can be used as a feasible and cost effective method to address WRUQMP.

Conversely to our findings, Gerr et al (2005a) showed that an ergonomic workstation intervention, similar to ours, was unlikely to reduce WRUQMP in computer users. This contradictory finding may be explained by two factors. Firstly, Gerr et al (2005a) reported that the relevant workstation adjustment was not always possible. This was primarily due to the required elbow position being impossible to achieve with the participant's workstation. Hence, not all subjects in their study could potentially benefit from the workstation adjustment. Secondly, Gerr et al (2005a) reported that compliance, measured at the time of intervention and at two subsequent follow-up visits, was poor in their sample. In our study, compliance was good as the subject did not alter her workstation after the intervention phase. This difference in compliance may thus explain the difference in findings between our study and Gerr et al (2005).

The subject in our study experienced low intensity pain, albeit frequent. This is typical of WRUQMP associated with computer use (Paksaichol et al 2012a, Punnett and Bergqvist 1997). The symptoms may be related to the subject's workstation (Straker et al 2008) as her VDU was too high for her anthropometry (table 2.3 and figure 2.4). Thus she had to look up at the screen, resulting in a 'thrown back' head position, hinging on the mid-lower cervical spinal structures.

This neck position has previously been significantly associated with neck MSD in computer users (Kaliniene et al 2013), possibly due to increased cervical spine compressive loading of the posterior structures and a creep response in the tissues (Harms-Ringdahl et al 1986, Edmondston et al 2011). In addition her elbows were below the level of the desk as her chair was too low (table 2.3 and figure 2.4). This relatively higher keyboard position has been shown to be associated with neck MSD in computer users (Gerr et al 2006, Waersted et al 2010). This position demands sustained shoulder blade elevation to reach the keyboard, further increasing posterior cervico-thoracic and upper trapezius muscle activity (Faucett and Rempel 1994, Straker and Mekhora 2000a). It has been hypothesised that the physiological consequences of this muscle overuse may result in localized muscle fatigue (Visser 2006), with insufficient muscle relaxation of low threshold motor units. (Hermens and Hutten 2002). This mechanism is thought to contribute to myofascial pain in computer users (Hagberg et al 1995). A workstation layout which enables a more neutral body alignment may result in less WRUQMP, due to reduced cervico-thoracic

muscle activation (McLean 2005) and reduced strain on cervical structures. This may have been the mechanism for the reduction in pain intensity seen in our study.

Although a reduction in pain intensity was noted in our study, some WRUQMP remained. This is consistent with the findings by Hoyle (2011) in which trapezius load was measured, while doing computer typing work under three workstation postural stress conditions. In this study increased trapezius load and WRUQMP was noted after all three working conditions, even in conditions compliant with current ergonomic guidelines for office work. Hoyle et al (2011) concluded that modification of the physical layout alone may not prevent musculoskeletal symptoms from occurring. Furthermore, Huysmans et al (2012) has reported previous neck and upper back symptoms as being the most important risk factor for future symptoms among office workers. Potentially, increased tissue vulnerability and sensitization of the pain system would explain the increased risk in this group. Our study subject had a previous history of WRUQMP and this may also be a further reason why she continued to experience some residual pain symptoms.

The secondary outcome of this study, to ascertain the effect of a chair and computer screen height adjustment on comfort level while sitting at work, shows that the subject became more uncomfortable after the intervention phase (figure 2.6). During the exit interview, the subject verbally reported to the researcher that she was comfortable at the workstation after the intervention. The subject indicated that the anchor labels 'very comfortable' and 'extremely uncomfortable', (figure 2.1) may have caused confusion, with 'greater comfort' assumed to involve a mark further to the right on the VADS. Mekhora et al (2000) reported using a VADS with anchors of 'discomfort' throughout ('no discomfort' vs 'extreme discomfort'), however when the VADS figure in the article is consulted the anchors are marked 'no pain' and 'extreme pain'. Gerr, et al (2005) used a VADS in which subjects were asked to rate the 'worst discomfort such as pain, aching, burning, numbness or tingling during the previous week'. Comfort is arguably a less often investigated construct compared to outcomes such as pain. Further research may be required to establish standardised methods to measure comfort. This will facilitate comparison between studies in the future.

Comfort has been defined as a “pleasant state or relaxed feeling of a human in reaction to its environment” (Vink and Hallbeck 2012). Thus a change in neck and upper back pain intensity need not correlate to a change in perceived sitting comfort, as the concept of comfort includes other body parts in which pain is felt as well as environmental and psychosocial factors (Vink and Hallbeck 2012). Interestingly, the subject did suffer an episode of her familiar lower back muscle tightness one week after the end of the study period. It is possible that the decreased comfort level may have been an early indicator of this MSD (Lindegard et al 2012a, Wahlstrom et al 2004), and that this may offer an alternative explanation for the increase in her VADS measurements.

WRUQMP in computer users is a multidimensional problem and various risk factors may interact to increase or buffer symptoms (Johnston et al 2009). Physical, environmental and psychosocial workplace factors are acknowledged factors which may affect the experience of WRUQMP (Johnston et al 2009). Thus, our study assessed potential confounding risk factors by means of questionnaires at entry, phase end and exit of the study and found known confounders to be constant (tables 2.5 and 2.6). Published studies have also used questionnaires to control for confounding factors (Aarås et al 1998, Mekhora et al 2000). Monitoring known confounders enabled us to ascertain if any of these factors influenced the study outcomes. The findings illustrated that none of these confounding factors influenced the outcomes of this subject. This strengthens the validity of our findings due to the intervention.

The subject was not blinded to the intervention and therefore the placebo effect may result in bias if she is under the impression that superior workstation ergonomics have been implemented (Mekhora et al 2000). Furthermore, the subject may have altered her behaviour because she was being observed as described by the Hawthorne effect (Adair 1984). In this case, the VAPS measurements would be expected to drop immediately at intervention and increase again gradually as measurements continued for eight weeks after the workstation adjustment. This was not the case and the placebo and Hawthorne effects are therefore unlikely to have had a notable effect on study outcomes.

## **Limitations and recommendations**

This was a single subject study of a single intervention, and the result may not be generalised to other population groups and ergonomic interventions. Similar studies with greater numbers of subjects, or the combination of multiple single subject studies similar to the present study, would enhance the validity of the findings, thus increasing the confidence with which clinicians may recommend this intervention. Furthermore, a desktop computer was used and the results of this study cannot be generalised to laptop, tablet or multiple screen workstation scenarios.

A strength of the studies by Esmailzadeh et al (2014) and Levanon et al (2012), is that these studies included self-report and objective workstation posture assessments respectively, at entry and exit of the study. Both studies reported an improvement in workstation posture. Esmailzadeh et al (2014) viewed the use of self-report posture assessment to be a limitation of their study as it may introduce bias, and noted that an objective measure would be preferable. An objective account of sitting posture is a superior method of postural examination compared to subjective or self-report measures as it can provide information about the biomechanical alignment of the bony structures at any specific moment in time (Brink and Louw 2013). No assessment of workstation posture and subsequent change to workstation posture after the workstation adjustment was included in our study and this is a limitation of the study.

Returning the subject's workstation to baseline settings after phase B for a washout period would have increased the validity of the findings. However as this subject reported less pain after the intervention phase and chose to keep her workstation at the adjusted height, this may have been regarded as unethical. Information regarding the use of pain medication was only gained in relation to neck and upper back pain which may have introduced bias as pain medication for other areas would also have affected the WRUQMP.

## **2.6 Conclusion**

The aim of this study was to ascertain whether a chair and VDU height adjustment would reduce WRUQMP in office workers who are computer users. The findings of this single subject study suggested that the vertical height adjustment of the chair and VDU may have contributed to a decrease in WRUQMP in this subject. This safe, economical workstation intervention may be a practical management option for the computer user suffering from WRUQMP. However a deterioration in sitting comfort

was noted. Further research with larger population studies and longer follow-up time frames is now required to affirm these findings in a representative sample.

## CHAPTER 3: SUMMARY AND CONCLUSION

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### 3.1 Contribution of the study to knowledge

Prolonged computer use has become customary in present-day office work environments (Wahlstrom et al 2004). This trend is mirrored by an increase in work related upper quadrant musculoskeletal pain (WRUQMP) especially among those who are intensive computer users (Jensen 2003, Paksaichol et al 2012a, Pillastrini and Mugnai 2010, Punnett and Bergqvist 1997). Prevalence rates of 45 -75% have been reported (Cho et al 2012, Griffiths et al 2012, Kaliniene et al 2013, Tornqvist et al 2009). Of concern is that the extent of the problem has not decreased over the past decade despite efforts in the workplace and advances in computer related equipment.

The increase in WRUQMP in computer users is of individual as well as economic concern, with notable cost implications due to absenteeism, decreased productivity and health care expenditure (Heinrich et al 2004). Clinical advice, workplace policies as well as government legislative policies need to be based on trustworthy scientific guidance (Waersted et al 2010). However, a strong level of evidence is still not available to support the viability of specific ergonomic interventions in WRUQMP in computer users (Andersen et al 2011). Further research is thus needed, with clearly defined results (Leyshon et al 2010) and adequate control of confounding factors (Gerr et al 2006), to be useful to professionals working directly with WRUQMP (Leyshon et al 2010). This study was thus undertaken to ascertain whether adjusting only the vertical height of the VDU and chair in relation to the computer user, would affect his/her WRUQMP and sitting comfort.

An N=1 study was undertaken with the subject being a female office worker whose work required that she use her computer for more than five hours a day and who had WRUQMP that was chronic in nature. The study was conducted with three phases of four weeks using an A-B-C design. The outcomes that were used to assess the effect of the chair and VDU height adjustment were self- reported 'neck and upper back pain' (primary outcome) and 'sitting comfort' (secondary outcome). A VAS was used to measure each outcome twice each week for the duration of the study. The subject was interviewed by the researcher and completed a questionnaire at entry

and exit of the study in order to monitor known confounding factors. This was important as the multidimensional nature of WRUQMP is well acknowledged (Johnston et al 2009). The data was captured on a Microsoft Excel 2010 spreadsheet and descriptive statistics were used to describe the data set. As a measure of central tendency the mean was calculated and the range was calculated as a measure of variability for each phase, for the outcomes of pain and comfort. In addition the effect sizes for the outcomes of pain and comfort were calculated.

The results relating to the primary outcome of WRUQMP demonstrated a reduction in the mean pain level. Furthermore, the variability of pain as indicated by the range (max-min), reduced from phase A to phase C. The reduced variability indicates a positive effect of the intervention, since more stability in symptoms was noted during the latter two phases. A small positive effect size was noted for the outcome of pain intensity from phase A to B and this was maintained from phase A to phase C, suggesting a durable effect. The hypothesis that symptoms of WRUQMP would be reduced following the ergonomic intervention of a height adjustment of chair and VDU, was thus demonstrated. The secondary outcome of this study, comfort level while sitting at work, shows that the subject became more uncomfortable after the intervention phase. The effect size for comfort level while sitting at work from phase A to phase B and from phase A to phase C showed a medium effect for an increase in *discomfort*.

### **3.2 Clinical implications**

This practical ergonomic intervention of a height adjustment of chair and VDU, would be economical and easy to implement, facilitating self-management for the office worker suffering from WRUQMP.

The basis for this intervention is that a change in the worker-workstation interface alters the postural demand placed on the worker, and subsequently the demand on his/her musculoskeletal system (Mekhora et al 2000). A workstation layout which enables a more neutral body alignment may result in less WRUQMP, due to reduced cervico-thoracic muscle activation (McLean 2005) and reduced strain on cervical structures. Although a reduction in pain intensity was noted in our study, some WRUQMP remained. Previous neck and upper back symptoms has been identified as being the most important risk factor for future symptoms among office workers



(Huysmans et al 2012). Potentially, increased tissue vulnerability and sensitization of the pain system would explain the increased risk in this group. Our study subject had a previous history of WRUQMP and this may also be a further reason why she continued to experience some residual pain symptoms.

The secondary outcome of this study, comfort level while sitting at work, shows that the subject became more uncomfortable after the intervention phase. There are two possible explanations for this result. Firstly, the anchor labels used for the VADS may have caused confusion, with improved comfort incorrectly assumed by the subject to be reflected by a mark further to the right on the VADS. This is possible as the subject verbally reported to the researcher that she was comfortable at the workstation after the intervention. However, a second explanation, relating to the concept of 'sitting comfort' exists. Comfort has been defined as "a pleasant state or relaxed feeling of a human in reaction to its environment" (Vink and Hallbeck 2012). The concept of comfort includes all body parts in which pain is felt as well as environmental and psychosocial factors (Vink and Hallbeck 2012) with a decrease in comfort level shown to be an early indicator of MSD (Lindegard et al 2012b, Wahlstrom et al 2004). Although the subject demonstrated a reduction in her WRUQMP, she did suffer an episode of her familiar lower back muscle tightness one week after the end of the study period, with this MSD possibly prefaced by the decreased comfort level

### **3.3 Recommendations for future research**

A strength of this study is that known confounders were monitored and found not to influence the outcomes in this subject. Furthermore, this study assessed a single ergonomic intervention of a simple workstation height adjustment and the results are therefore likely to be attributable to this specific intervention. A limitation of the study is that this was a single subject study and results may therefore not be generalised. Similar studies with greater numbers of subjects would increase the confidence with which clinicians may recommend this intervention. Furthermore no assessment of workstation posture, and subsequent change to workstation posture after the intervention, was included in our study. It is suggested that an objective workstation posture measurement be included in future studies to assess whether a change in WRUQMP is in fact related to a change in body alignment of the worker at the workstation. Furthermore, the VADS may have been misinterpreted by the subject

due to the anchor labels used in this study. Comfort is arguably a less often investigated construct compared to outcomes such as pain. Further research may be required to establish standardised methods to measure comfort. This will facilitate comparison between studies in the future.

### 3.4 Conclusion

In conclusion, the findings of this single subject study suggest that the vertical height adjustment of the chair and VDU may have contributed to a decrease in WRUQMP in this subject. This safe, economical workstation intervention may be a practical management option for the computer user suffering from WRUQMP. A deterioration was noted in sitting comfort. Further research into the measurement of comfort whilst sitting at a computer workstation, is recommended.

## REFERENCES

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- Aarås A, Horgen G, Bjørset H, Ro O And Thoresen M 1998 Musculoskeletal, visual and psychosocial stress in VDU operators before and after multidisciplinary ergonomic interventions. *Applied Ergonomics* 29(5): 335-354
- Aarås A, Horgen, G, Bjørset, H, Ro O And Walsøe H 2001 Musculoskeletal, visual and psychosocial stress in VDU operators before and after multidisciplinary ergonomic interventions. A 6 years prospective study - Part II. *Applied Ergonomics* 32(6): 559-571
- Adair JG, 1984. The Hawthorne effect: A reconsideration of the methodological artifact. *Journal of Applied Psychology* 69(2): 334-345
- Andersen JH, Fallentin N, Thomse, JF And Mikkelsen S 2011 Risk factors for neck and upper extremity disorders among computers users and the effect of interventions: an overview of systematic reviews. *PLoS One* 6(5):e19691
- Ariens G, Van Mechelen W, Bongers PM, Bouter L And Van Der Wal G 2000 Physical risk factors for neck pain. *Scandinavian journal of work, environment & health* 26: 7-8-19

- Bergqvist U, Wolgast E, Nilsson B And Voss M 1995 Musculoskeletal disorders among visual display terminal workers: individual, ergonomic, and work organizational factors. *Ergonomics* 38(4): 763-776
- Boocock MG, Mcnair PJ, Larmer PJ, Armstrong B, Collier J, Simmonds M And Garrett N 2007 Interventions for the prevention and management of neck/upper extremity musculoskeletal conditions: a systematic review. *Occupational and environmental medicine* 64(5): 291-303
- Borg-Stein J, Dugan SA And Gruber J, 2005 Musculoskeletal aspects of pregnancy. *American journal of physical medicine & rehabilitation* 84(3): 180-192
- Brage S And Bjerkedal T 1996 Musculoskeletal pain and smoking in Norway. *Journal of epidemiology and community health* 50(2): 166-169
- Brewer S, Van Eerd D, Amick Iii, Benjamin C, Irvin E, Daum KM, Gerr F, Moore JS, Cullen K And Rempel D 2006 Workplace interventions to prevent musculoskeletal and visual symptoms and disorders among computer users: a systematic review. *Journal of Occupational Rehabilitation* 16(3): 317-350
- Brink Y And Louw QA 2013 A systematic review of the relationship between sitting and upper quadrant musculoskeletal pain in children and adolescents. *Manual therapy* 18(4): 281-288
- Bruno Garza J, Eijkelhof B, Johnson P, Raina S, Rynell P, Huysmans M, Van Dieën J, Van Der Beek A, Blatter B And Dennerlein J 2012 Observed differences in upper extremity forces, muscle efforts, postures, velocities and accelerations across computer activities in a field study of office workers. *Ergonomics* 55(6): 670-681
- Cagnie B, Danneels L, Van Tiggelen D, De Loose V And Cambier D 2007 Individual and work related risk factors for neck pain among office workers: a cross sectional study. *European Spine Journal* 16(5): 679-686
- Cho C, Hwang Y And Cherng R 2012 Musculoskeletal symptoms and associated risk factors among office workers with high workload computer use. *Journal of manipulative and physiological therapeutics* 35(7): 534-540
- Corlett EN, Bishop RP 1976 A technique for assessing postural discomfort. *Ergonomics* 19(2): 175-176-182
- Cote P, Van Der Velde G, Cassidy JD, Carroll LJ, Hogg-Johnson S, Holm LW, Carragee EJ, Haldeman S, Nordin M, Hurwitz EL, Guzman J, Peloso PM 2009 The burden and determinants of neck pain in workers: results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *Journal of manipulative and physiological therapeutics* 32(2 Suppl): S70-86

- Davis KG, Kotowski SE 2014 Postural Variability An Effective Way to Reduce Musculoskeletal Discomfort in Office Work. *Human Factors: The Journal of the Human Factors and Ergonomics Society* 018720814528003
- Devereux J, Vlachonikolis I, Buckle P 2002 Epidemiological study to investigate potential interaction between physical and psychosocial factors at work that may increase the risk of symptoms of musculoskeletal disorder of the neck and upper limb. *Occupational and environmental medicine* 59(4): 269-277
- Doll HA, Petersen SE, Stewart- Brown SL 2000 Obesity and physical and emotional well- being: associations between body mass index, chronic illness, and the physical and mental components of the SF- 36 questionnaire. *Obesity research* 8(2): 160-170
- Edmondston S, Björnsdóttir G, Pálsson T, Solgård H, Ussing K, Allison G 2011 Endurance and fatigue characteristics of the neck flexor and extensor muscles during isometric tests in patients with postural neck pain. *Manual therapy* 16(4): 332-338
- Eltayeb SM, Staal JB, Khamis AH, De Bie RA 2011 Symptoms of neck, shoulder, forearms, and hands: a cohort study among computer office workers in Sudan. *The Clinical journal of pain* 27(3): 275-281
- Esmaeilzadeh S, Ozcan E, Capan N 2014 Effects of ergonomic intervention on work-related upper extremity musculoskeletal disorders among computer workers: a randomized controlled trial. *International archives of occupational and environmental health* 87(1): 73-83
- Evans O, Patterson K 2000 Predictors of neck and shoulder pain in non-secretarial computer users. *International Journal of Industrial Ergonomics* 26(3): 357-365
- Fabrizio P 2009 Ergonomic intervention in the treatment of a patient with upper extremity and neck pain. *Physical Therapy* 89: 351-360
- Faucett J, Rempel D 1994 VDT related musculoskeletal symptoms: Interactions between work posture and psychosocial work factors. *American Journal of Industrial Medicine* 26(5): 597-612
- Ferraz MB, Quaresma M, Aquino L, Atra E, Tugwell P, Goldsmith C 1990 Reliability of pain scales in the assessment of literate and illiterate patients with rheumatoid arthritis. *The Journal of rheumatology* 17(8): 1022-1024
- Gerr F, Marcus M, Monteilh C, Hannan L, Ortiz D, Kleinbaum D 2005a A randomised controlled trial of postural interventions for prevention of musculoskeletal symptoms among computer users. *Occupational and environmental medicine* 62(7): 478-487

- Gerr F, Monteilh C, Marcus M 2006 Keyboard use and musculoskeletal outcomes among computer users. *Journal of Occupational Rehabilitation* 16(3): 265-266-277
- Gerr F, Marcus M, Monteilh C 2004a Epidemiology of musculoskeletal disorders among computer users: lesson learned from the role of posture and keyboard use. *Journal of Electromyography and Kinesiology* 14(1): 25-31
- Griffiths KL, Mackey MG, Adamson BJ 2007 The impact of a computerized work environment on professional occupational groups and behavioural and physiological risk factors for musculoskeletal symptoms: a literature review. *Journal of Occupational Rehabilitation* 17(4): 743-765
- Griffiths KL, Mackey MG, Adamson BJ, Pepper KL 2012 Prevalence and risk factors for musculoskeletal symptoms with computer based work across occupations. *Work: A Journal of Prevention, Assessment and Rehabilitation* 42(4): 533-541
- Hagberg M, Silverstein BA, Wells R, Smith M, Hendrick H, Carayon P, Perusse M 1995 Work related musculoskeletal disorders. *BMJ* 313:410-422
- Hamberg-Van Reenen HH, Van Der Beek AJ, Blatter BM, Van Der Grinten, Maarten P, Van Mechelen W, Bongers PM 2008 Does musculoskeletal discomfort at work predict future musculoskeletal pain? *Ergonomics* 51(5): 637-648
- Harms-Ringdahl K, Ekholm J, Schüldt K, Nemeth G, Arborelius UP 1986 Load moments and myoelectric activity when the cervical spine is held in full flexion and extension. *Ergonomics* 29(12): 1539-1552
- Hermens HJ, Hutten MM 2002 Muscle activation in chronic pain: its treatment using a new approach of myofeedback. *International Journal of Industrial Ergonomics* 30(4): 325-336
- Heinrich J, Blatter BM, Bongers PM 2004 A comparison of methods for the assessment of postural load and duration of computer use. *Occupational and Environmental Medicine* (61): 1027-1031
- Hill JC, Dunn KM, Lewis M, Mullis R, Main CJ, Foster NE 2008 A primary care back pain screening tool: identifying patient subgroups for initial treatment. *Arthritis Rheum* 59(5):632–41
- Hochanadel CD 1995 Computer workstation adjustment: a novel process and large sample study. *Applied Ergonomics* 26(5): 315-326
- Hoeben C, Louw QA 2014 Ergonomic chair intervention: Effect on chronic upper quadrant dysfunction, disability and productivity in female computer workers. *South African Journal of Physiotherapy* 70(2): 11-18

- Hoyle JA, Marras WS, Sheedy JE, Hart, DE 2011 Effects of postural and visual stressors on myofascial trigger point development and motor unit rotation during computer work. *Journal of electromyography and kinesiology* 21(1): 41-48
- Huysmans MA, Ijmker S, Blatter BM, Knol DL, Van Mechelen W, Bongers PM, Van Der Beek AJ 2012 The relative contribution of work exposure, leisure time exposure, and individual characteristics in the onset of arm–wrist–hand and neck–shoulder symptoms among office workers. *International archives of occupational and environmental health* 85(6): 651-666
- Ijmker S, Huysmans MA, Van Der Beek AJ, Knol DL, Van Mechelen W, Bongers PM, Blatter BM 2011 Software-recorded and self-reported duration of computer use in relation to the onset of severe arm-wrist-hand pain and neck-shoulder pain. *Occupational and environmental medicine* 68(7): 502-509
- Jensen C 2003 Development of neck and hand-wrist symptoms in relation to duration of computer use at work. *Scandinavian journal of work, environment & health*: 197-205
- Jensen C, Borg V, Finsen L, Hansen K, Juul-Kristensen B, Christensen H 1998 Job demands, muscle activity and musculoskeletal symptoms in relation to work with the computer mouse. *Scandinavian journal of work, environment & health*: 418-424
- Johnston V, Jimmieson NL, Jull G, Souvlis T 2010 Contribution of individual, workplace, psychosocial and physiological factors to neck pain in female office workers. *European journal of pain* 13(9): 985-991
- Kaliniene G, Ustinaviciene R, Skemiene L, Januskevicius V 2013 Associations between neck musculoskeletal complaints and work related factors among public service computer workers in Kaunas. *International journal of occupational medicine and environmental health*: 1-12
- Kamwendo K, 1991 Neck and Shoulder disorders in medical secretaries. part II. Ergonomic work environment and symptom profile. *Scandinavian journal of rehabilitation medicine* 23(3): 135-142
- Keswani S, Loungni L, Alexander T, Hassan H, Al Sharbatti S, Shaikh RB, Mathew E 2013 Musculoskeletal Pain among Computer Users. *Indian Journal of Physiotherapy and Occupational Therapy* 7(1): 90
- Korhonen T, Ketola R, Toivonen R, Luukkonen R, Hakkanen M, Viikari-Juntura E 2003 Work related and individual predictors for incident neck pain among office employees working with video display units. *Occupational and environmental medicine* 60(7): 475-482

- Levanon Y, Gefen A, Lerman Y, Givon U, Ratzon NZ 2012 Reducing musculoskeletal disorders among computer operators: comparison between ergonomics interventions at the workplace. *Ergonomics* 55(12): 1571-1585
- Leyshon R, Chalova K, Gerson L, Savtchenko A, Zakrzewski R, Howie A, Shaw L 2010 Ergonomic interventions for office workers with musculoskeletal disorders: a systematic review. *Work: A Journal of Prevention, Assessment and Rehabilitation* 35(3): 335-348
- Lindegard A, Wahlstrom J, Hagberg M, Vilhelmsson R, Toomingas A, Tornqvist EW 2012a Perceived exertion, comfort and working technique in professional computer users and associations with the incidence of neck and upper extremity symptoms. *BMC Musculoskeletal Disorders* 13: 38-2474-13-38
- McClean L 2005 The effect of postural correction on muscle activation amplitudes recorded from the cervicobrachial region. *Journal of electromyography and kinesiology: official journal of the International Society of Electrophysiological Kinesiology* 15(6): 527-535
- Mekhora K, Liston C, Nanthavanij S, Cole JH 2000 The effect of ergonomic intervention on discomfort in computer users with tension neck syndrome. *International Journal of Industrial Ergonomics* 26(3): 367-379
- Mikkelsen S, Vilstrup I, Lassen CF, Kryger AI, Thomsen JF, Andersen JH 2007 Validity of questionnaire self-reports on computer, mouse and keyboard usage during a four-week period. *Occupational and environmental medicine* 64(8): 541-547
- Miles CL, Pincus T, Carnes D, Homer KE, Taylor SJ, Bremner SA, Rahman A, Underwood M 2011 Can we identify how programmes aimed at promoting self-management in musculoskeletal pain work and who benefits? A systematic review of sub-group analysis within RCTs. *European Journal of Pain* 15(8): 775 e1-775. e11
- Nanthavanij S, Venezia D 1999 Estimation of recommended VDT workstation settings from operator's body height and gender. *Industrial Engineering Research* 1(1): 90-103
- Ostelo RW, Deyo RA, Stratford P, Waddell G, Croft P, Von Korff M, Bouter LM, Henrica C 2008 Interpreting change scores for pain and functional status in low back pain: towards international consensus regarding minimal important change. *Spine* 33(1): 90-94
- Paksaichol A, Janwantanakul P, Purepong N, Pensri P, Van Der Beek AJ 2012a, 2012b Office workers' risk factors for the development of non-specific neck pain: a

- systematic review of prospective cohort studies. *Occupational and environmental medicine* 69(9): 610-618
- Petty NJ 2011 *Principles of Neuromusculoskeletal Treatment and Management, A Handbook for Therapists*. Churchill Livingstone Elsevier, London.
- Pillastrini P, Mugnai R, Farneti C, Bertozzi L, Bonfiglioli R, Curti S, Mattioli S and Violante FS 2007 Evaluation of two preventive interventions for reducing musculoskeletal complaints in operators of video display terminals. *Physical Therapy* 87(5): 536-544
- Pillastrini P, Mugnai R 2010 Effectiveness of an ergonomic intervention on work related posture and lower back pain in video display terminal operators: a 3 year cross-over trial. *Applied Ergonomics* 41(3): 436
- Psihogios, J.P., Sommerich, C.M., Mirka, G.A. And Moon S.D 2001 A field evaluation of monitor placement effects in VDT users. *Applied Ergonomics* 32(4): 313-325
- Punnett L, Bergqvist U 1997 *Visual display unit work and upper extremity musculoskeletal disorders*. Solna
- Rahman ZA, Atiya AS 2009 Prevalence of work-related upper limbs symptoms (WRULS) among office workers. *Asia-Pacific Journal of Public Health* 21(3): 252-258
- Reips U, Funke F 2008 Interval-level measurement with visual analogue scales in Internet-based research: VAS Generator 40(3): 699-700-704
- Rempel DM, Wang PC, Janowitz I, Harrison RJ, Yu F, Ritz BR 2007 A randomized controlled trial evaluating the effects of new task chairs on shoulder and neck pain among sewing machine operators: the Los Angeles garment study. *Spine* 32(9): 931-938
- Richter JM, Van Den Heuvel SG, Huysmans MA, Van Der Beek AJ, Blatter BM 2012 Is peak exposure to computer use a risk factor for neck and upper-extremity symptoms? *Scandinavian journal of work, environment & health* 38(2) 155-162
- Shin SJ, Yoo WG 2013 Changes in cervical range of motion, flexion-relaxation ratio and pain with visual display terminal work. *Work* 47: 261-265
- Silverstein BA, Adams D, Kalat J 2004 *Work related musculoskeletal disorders of the neck, back and upper extremity in Washington State*. Safety and Health Assessment and Research for Prevention (SHARP) Technical Report Number 40-4a-2000
- Skov T, Borg V, Orhede E 1996 Psychosocial and physical risk factors for musculoskeletal disorders of the neck, shoulders and lower back in sales people. *Occupational and environmental medicine* 53(5): 351



- Sommerich CM, Joines S, Psihogios JP 2001 Effects of computer monitor viewing angle and related factors on strain, performance, and preference outcomes. *Human Factors: The Journal of the Human Factors and Ergonomics Society* 43(1): 39-55
- Straker L, Mekhora K 2000a, 2000b An evaluation of visual display unit placement by electromyography, posture, discomfort and preference. *International Journal of Industrial Ergonomics* 26(3): 389-398
- Straker L, Burgess-Limerick R, Pollock C, Murray K, Netto K, Coleman J, Skoss R, 2008 The impact of computer display height and desk design on 3D posture during information technology work by young adults. *Journal of electromyography and kinesiology: official journal of the International Society of Electrophysiological Kinesiology* 18: 336.
- Szeto GP, Chan CC, Chan SK, Lai H, Lau E 2014 The effects of using a single display screen versus dual screens on neck-shoulder muscle activity during computer tasks. *International Journal of Industrial Ergonomics* 44(3): 460-465
- Szeto GP, Straker L, Raine S 2002 A field comparison of neck and shoulder postures in symptomatic and asymptomatic office workers. *Applied Ergonomics* 33(1): 75-84
- Tittiranonda P, Burastero S, Rempel D 1999 Risk factors for musculoskeletal disorders among computer users. *Occupational medicine* 14(1): 17-38
- Tornqvist EW, Hagberg M, Hagman M, Risberg EH, Toomingas A 2009 The influence of working conditions and individual factors on the incidence of neck and upper limb symptoms among professional computer users. *International archives of occupational and environmental health* 82(6): 689-702
- Troussier B, Tesniere C, Fauconnier J, Grisson J, Juvin R, Phelip X 1999 Comparative study of two different kinds of school furniture among children. *Ergonomics* 42(3): 516
- Van Den Heuvel S, Van Der Beek A, Blatter B, Bongers P 2006 Do work-related physical factors predict neck and upper limb symptoms in office workers? *International archives of occupational and environmental health* 79(7): 585-592
- Van Niekerk SM, Louw QA, Hillier S 2012 The effectiveness of a chair intervention in the workplace to reduce musculoskeletal symptoms. A systematic review. *BMC musculoskeletal disorders* 13: 145-2474-13-145
- Varatharajan S, Côté P, Shearer HM, Loisel P, Wong JJ, Southerst D, Yu H, Randhawa K, Sutton D, Van Der Velde G 2014 Are work disability prevention interventions effective for the management of neck pain or upper extremity

- disorders? A systematic review by the Ontario Protocol for Traffic Injury Management (OPTIMa) Collaboration. *Journal of Occupational Rehabilitation* DOI 10.1007/s10926-014-9501-1
- Vink P, Hallbeck S 2012 Editorial: comfort and discomfort studies demonstrate the need for a new model. *Applied Ergonomics* 43(2): 271-276
- Visser B, VD 2006 Pathophysiology of upper extremity muscle disorders. *Journal of Electromyography and Kinesiology* 16(1): 1-16
- Waersted M, Hanvold TN, Veiersted KB 2010 Computer work and musculoskeletal disorders of the neck and upper extremity. A systematic review. *BMC Musculoskeletal Disorders* 11:79
- Wahlstrom J, Hagberg M, Toomingas A, Tornqvist EW 2004 Perceived muscular tension, job strain, physical exposure, and associations with neck pain among VDU users; a prospective cohort study. *Occupational and environmental medicine* 61(6): 523-528
- Zenk R, Franz M, Bubb H, Vink P 2012 Technical note: Spine loading in automotive seating. *Applied Ergonomics* 43(2): 290-295



# APPENDICES

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## **Appendix 1: SASP Guidelines for article submission**

The following guidelines for authors are supplied online:

<http://www.physiosa.org.za/sites/default/files/JRL%20Guidelines%20Final.pdf>

### **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).

## **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, e.g. Armstrong (1990), Jones (1988) and Smith and Jones (1990) refer to similar findings. When there are two authors of a paper, mention both, e.g. Smith and Jones (1990), but when there are three or more, mention only the principal author and follow with et al, e.g. 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 letters<sup>1</sup>).

1) Payton OD 1994 Research: The validation of clinical practice, 3<sup>rd</sup> edn. Ppl 51-156. F.A. Davis Company, Philadelphia.

2) Shephard KF 1993 Questionnaire design and use. In: Bork CE (ed) Research in Physical Therapy, ppl76-204. 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.

## Appendix 2: Ethics approval



UNIVERSITEIT STELLENBOSCH UNIVERSITY  
Job kennis en ontuit • your knowledge partner

### 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](http://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](mailto:healthres@pgwc.gov.za) Tel: +27 21 483 9907) and Dr Helene Visser at City Health ([Helene.Visser@capetown.gov.za](mailto: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](http://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



Decl van Vledder

CV Williams

Protocol

Decl Erntzen

Protocol Synopsis

CV van Vledder

CV Muller

Decl Saggu

Checklist

Application Form

Cv Erntzen

Consent

Decl Williams

Sincerely,

Franklin Weber

HREC Coordinator

Health Research Ethics Committee 1

# Investigator Responsibilities

## Protection of Human Research Participants

Some of the responsibilities investigators have when conducting research involving human participants are listed below:

- 1. Conducting the Research.** You are responsible for making sure that the research is conducted according to the HREC approved research protocol. You are also responsible for the actions of all your co-investigators and research staff involved with this research.
- 2. Participant Enrolment.** You may not recruit or enrol participants prior to the HREC approval date or after the expiration date of HREC approval. All recruitment materials for any form of media must be approved by the HREC prior to their use. If you need to recruit more participants than was noted in your HREC approval letter, you must submit an amendment requesting an increase in the number of participants.
- 3. Informed Consent.** You are responsible for obtaining and documenting effective informed consent using **only** the HREC-approved consent documents, and for ensuring that no human participants are involved in research prior to obtaining their informed consent. Please give all participants copies of the signed informed consent documents. Keep the originals in your secured research files for at least fifteen (15) years.
- 4. Continuing Review.** The HREC must review and approve all HREC-approved research protocols at intervals appropriate to the degree of risk but not less than once per year. There is **no grace period**. Prior to the date on which the HREC approval of the research expires, it is **your responsibility to submit the continuing review report in a timely fashion to ensure a lapse in HREC approval does not occur**. If HREC approval of your research lapses, you must stop new participant enrolment, and contact the HREC office immediately.
- 5. Amendments and Changes.** If you wish to amend or change any aspect of your research (such as research design, interventions or procedures, number of participants, participant population, informed consent document, instruments, surveys or recruiting material), you must submit the amendment to the HREC for review using the current Amendment Form. You **may not initiate** any amendments or changes to your research without first obtaining written HREC review and approval. The **only exception** is when it is necessary to eliminate apparent immediate hazards to participants and the HREC should be immediately informed of this necessity.
- 6. Adverse or Unanticipated Events.** Any serious adverse events, participant complaints, and all unanticipated problems that involve risks to participants or others, as well as any research-related injuries, occurring at this institution or at other performance sites must be reported to the HREC within **five (5) days** of discovery of the incident. You must also report any instances of serious or continuing problems, or non-compliance with the HRECs requirements for protecting human research participants. The only exception to this policy is that the death of a research participant must be reported in accordance with the Stellenbosch University Health Research Ethics Committee Standard Operating Procedures [www.sun025.sun.ac.za/portal/page/portal/Health\\_Sciences/English/Centres%20and%20Institutions/Research\\_Development\\_Support/Ethics/Application\\_package](http://www.sun025.sun.ac.za/portal/page/portal/Health_Sciences/English/Centres%20and%20Institutions/Research_Development_Support/Ethics/Application_package) All reportable events should be submitted to the HREC using the Serious Adverse Event Report Form.
- 7. Research Record Keeping.** You must keep the following research-related records, at a minimum, in a secure location for a minimum of fifteen years: the HREC approved research protocol and all amendments; all informed consent documents; recruiting materials; continuing review reports; adverse or unanticipated events; and all correspondence from the HREC
- 8. Reports to the MCC and Sponsor.** When you submit the required annual report to the MCC or you submit required reports to your sponsor, you must provide a copy of that report to the HREC. You may submit the report at the time of continuing HREC review.
- 9. Provision of Emergency Medical Care.** When a physician provides emergency medical care to a participant without prior HREC review and approval, to the extent permitted by law, such activities will not be recognised as research nor will the data obtained by any such activities should it be used in support of research.
- 10. Final reports.** When you have completed (no further participant enrolment, interactions, interventions or data analysis) or stopped work on your research, you must submit a Final Report to the HREC.
- 11. On-Site Evaluations, MCC Inspections, or Audits.** If you are notified that your research will be reviewed or audited by the MCC, the sponsor, any other external agency or any internal group, you must inform the HREC immediately of the impending audit/evaluation.

## **Appendix 3: Signed informed consent**

## **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 Saggu

**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](mailto:gavinix@hotmail.com) or 0761019096
- Sabine Muller on [sabinem@mweb.co.za](mailto:sabinem@mweb.co.za) or 0833754466
- Rajinder Saggu on [rsaggu2@gmail.com](mailto:rsaggu2@gmail.com) or 0712777216

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.

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 work station.

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 in 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.

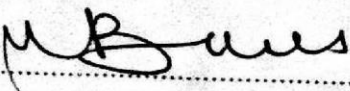
**Declaration by participant**

By signing below, I  ..... 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) CONSTANTIA Medi-Clinic (date) 18 March 2014  
2014.

  
.....

**Signature of participant**

## Appendix 4: Letter to Constantiaberg Mediclinic Human Resources Department

University of Stellenbosch  
Faculty of Medicine and Health Sciences  
Tygerberg Campus  
P.O. Box 19063  
Tygerberg  
7505  
4 September 2013

Mediclinic Constantiaberg  
Burnham Road  
Plumstead  
7800

Dear Mrs de Villiers

### **Re: Request to conduct a Physiotherapy Masters study at your premises.**

We are Physiotherapy Masters students at the University of Stellenbosch. We are currently conducting a study to investigate the effect of adjusting the vertical workstation parameters of an office worker on their neck and upper back pain.

The study would take place at the workers' habitual workstation during office hours. It will require your administration staff to complete an initial screening questionnaire which will enable us to identify potential study participants. We will then measure the vertical workstation parameters of this group. Those workers whose workstation is deemed to be sub-optimal according to current evidence based literature will be eligible to participate.

The procedure will be as follows: For four weeks the subject's workstation will remain unchanged. During this time we will monitor their symptoms biweekly using a 2 item questionnaire. They will be asked to score their pain level and the perceived comfort of their work position over the past 2/3 days. This will take less than one minute to complete and return to us. This phase allows us to establish their baseline symptoms.

Thereafter the workstation will be adjusted, and for a further four weeks biweekly monitoring of their symptoms will continue. The workstation will then be returned to the original setting, and a final four weeks of biweekly monitoring will take place.

In summary this will require the selected staff member to fill in a biweekly one minute questionnaire for a period of twelve weeks. Should the above be acceptable to you, kindly supply us with a brief letter of consent.

Regards

Nicole van Vledder, Sabine Muller and Rajinder Saggu



## Appendix 5: A Letter from Constantiaberg Mediclinic

### *Letter from Constantiaberg Mediclinic*

----- Original message -----

From: "De Villiers, Janine" <[janine.devilliers@mediclinic.co.za](mailto:janine.devilliers@mediclinic.co.za)>

Date: 04/09/2013 14:55 (GMT+02:00)

To: [sabinem@mweb.co.za](mailto:sabinem@mweb.co.za)

Subject: FW: Physiotherapy Research

Dear Nicole,

I hereby confirm that we are willing to participate in the study utilising staff members from our Administrative department as your study participants.

I would also appreciate it, if possible, if you are able to provide us with your findings on its completion.

Kind Regards,

**Janine de Villiers**

Patient Administration Manager

**MEDICLINIC CONSTANTIABERG**

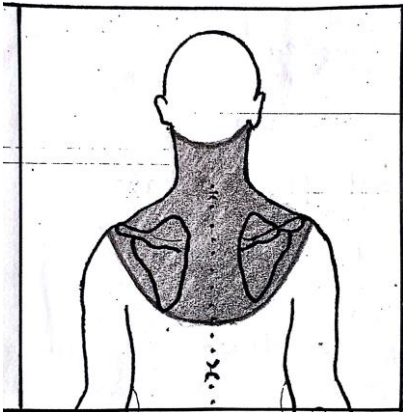
Burnham Road  
Plumstead, 7800  
PO Box 179  
Plumstead, 7800  
T +27 21 799 2911  
F +27 86 682 7019  
[www.mediclinic.co.za](http://www.mediclinic.co.za)

## Appendix 6: Screening Questionnaire

### 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:

	YES	NO
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? _____		

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? Eg 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 3months?		

## Appendix 7: Entry Questionnaire

### ENTRY QUESTIONNAIRE

Date: 18/3/2014

1. **Name:** Subject 1
2. **Age:** 38
3. **Sex:** MALE/ FEMALE
4. **Upper Limb dominance:** RIGHT / LEFT
5. **Occupation:** Credit controller (full time) at Mediclinic Hospital [done this 10 years] ; This involves sitting at computer most of the 8 hour day, short periods dealing with patients face to face, rarely looking at a file, mostly straight at screen, answering queries over the phone (uses a headset which she requested due to previous neck ache , had headset 2 years)
6. **Frequency of breaks** from sitting computer work: works 7:30 to 4pm, tea 10:00 for 15 min, lunch 1:00 for 30 min, tea 3:00 for 15 minutes
7. **Shoe heel height** commonly worn to work: flat in summer, shoes with court shoe heel in winter
8. **Hobbies:** cooking, church activities ; planning church events, gets neck and back massage from a friend
9. **Sports/ recreation:** likes to walk on the beach with daughter every 2<sup>nd</sup> weekend for 1 hour; walks 1 mile to bus morning and evening ( new started this beginning of year)
10. **Frequency of sports/** heavy physical activity causing sweating during the past 4 months?
  - a. More than 3 times/ week
  - b. 1-2 times/ week
  - c. 1-3 times/month
  - d. Less than 1time/month
11. **Social/family situation** (and any recent changes which may impact on the neck or upper back symptoms):  
Single mom, 1 daughter 7 years old (Mia), lives with daughter just the 2 of them
12. **GENERAL HEALTH:** If yes, what treatment are you currently receiving?
  - a. Rheumatoid arthritis: NO
  - b. Diabetes: NO
  - c. High Blood Pressure: NO
  - d. Osteoporosis: NO
  - e. History of Cancer: NO

- f. History of Tuberculosis: NO
- g. Unexplained night sweats: NO

13. **Have you undergone any recent surgeries?** Caesarean section

14. **Pharmaceutical history:**

- a. Are you currently taking any medication for chronic diseases: please specify No
- b. Have you previously or are you currently taking cortisone for longer than a 2 week period? No
- c. Are you currently taking any medication for pain relief? Please specify which one, and how often? Intermittent use of Panado and Mypradol for back and neck pain( mainly for back pain)

15. **Have you noticed any of the following symptoms:** No red flags below

- a. Changes in the bladder and bowel patterns \_\_\_\_\_
- b. Pins and needles in your hands and / feet \_\_\_\_\_
- c. Changes in your walking pattern/ unsteadiness in the gait \_\_\_\_\_
- d. Balance problems \_\_\_\_\_
- e. Dizziness or fainting \_\_\_\_\_
- f. Unexplained weight loss \_\_\_\_\_

Other medical: noticed periods have changed in the last few months, flow varies and pain and duration all vary

16. **Participants main complaint :** Ache across the neck and upper back after working at the computer the whole day. Intermittent episodes of severe neck spasm pain ? related to computer, sleeping position not sure. Intermittent episodes of LBP.

17. **What is the participants idea of causation, concerns, expectations regarding their neck and upper back symptoms :** Positive coping: manages stress with what she takes on as she knows this affects her neck and back pain. Takes a vitamin supplement to keep her healthy.

18. **History of neck and upper back symptoms ( and past)**

- a. Current : ? 4 years intermittent episodes of severe neck spasm, may be L or R, may wake with it or notice it increasing in the day. Severe, will go to GP and may get Voltaren injection, and written off work 2-3 days. If does not settle goes to physio for massage to work out knots. Has been going to physio for 4 years intermittently. Period of spasm eases in around 1 week with physio or not. Normally happens every 3 months. Wonders if related to sleeping position or stress, first started happening when more stress and this is why she paces herself regarding activities at home/

other responsibilities. Manages it also with a once off ½ sleeping tablet to relax the muscles for the night, this works well. Also ache across the R and L neck and shoulder area to T4 with working in front of the computer. Not noticed it at weekends. On workdays it is better mornings, worse late afternoon. Notices it when she relaxes after concentrating and being busy at work.

- b. Back pain many years across the lower back intermittent. This is normally why she will go to physio. No reasons (structural) given to her for her neck and back pain. Considers it muscle spasm and tightness due to work and stress. If LBP worse, she sits differently and this may make her neck and upper back pain worse at the computer.
- c. Past Relevant: see above

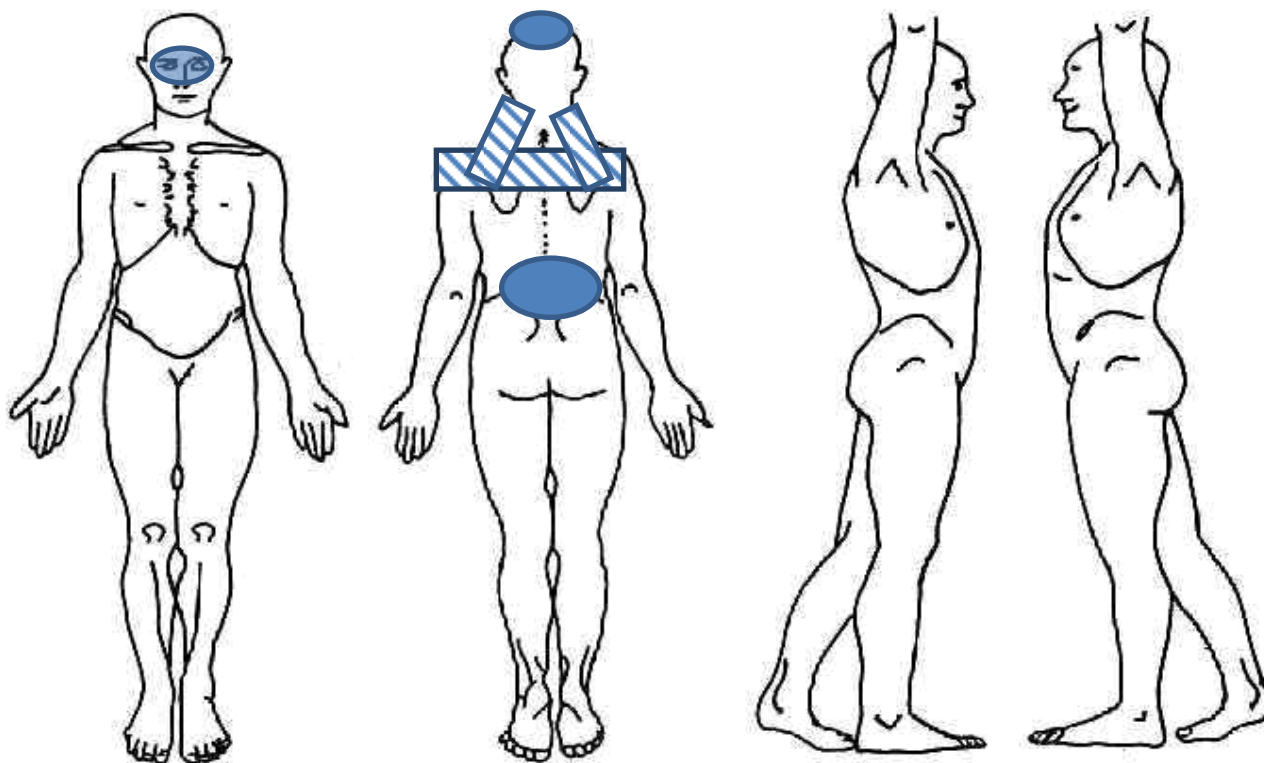
### **19. Specific questions**

- a. Pillow (size and content): 1, fills neck and shoulder gap
- b. Bed mattress (age and firmness): feels it needs to be changed, 6 yrs old.
- c. Sleeping position: sidely, when her back sore may lie supine
- d. Glasses (when used, last optometry appointment or script change, when due for another change?) NO
- e. Driving, carrying, sleeping, working, reading, other (if not already discussed) Drives and gets on with life, does not always affect her back, only intermittent when having an episode of back pain.

### **20. Special investigations**

None, no x rays/blood tests

## Area of Symptoms: Tick arms



<p><b>Area 1</b> paraspinal neck, side varies or both</p> <p><b>Nature</b> ache, stiff, pain (not burning)</p> <p><b>Severity</b> 0/10 to 10/10 if spasm pain; ache mid morning at assessment 3/10</p> <p><b>Intermittent</b></p>	<p><b>Area A2</b> across upper back,</p> <p><b>Nature</b> ache, pain</p> <p><b>Severity</b> 0/10 to 8/10</p> <p><b>Intermittent</b></p>	<p><b>Area A3</b> top of head and through to eyes, unilateral or bilateral.</p> <p><b>Nature:</b> pain, sore</p> <p><b>Severity</b> 0/10 to</p> <p><b>Intermittent</b></p>	<p><b>Area 4 :</b> nonspecific LBP</p> <p><b>Nature;</b> Sore. Ache</p> <p><b>Severity:</b> 0/10 to 8/10</p> <p><b>Intermittent</b></p>
---	---	--	---

A1 first, A2 and A3 may accompany A1

A4 separate but A1, A2, A3 may follow severe episode of A4

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

	AREA 1 [Area 2 and 3 when A1 severe]	Area 4
<b>24 HR PATTERN</b> Night: Waking up: Daily Pattern:	Not painful Better if general ache A1, A2, A3, Worse late afternoon and notices it when relaxing after work (when you unwind).Weekend days it does not get worse in the afternoon.	Severe, worse when painful episode, gets better with movement.
<b>AGGRAVATING FACTORS</b>	Time sitting at desk, general stress (pressure), AC directly over her neck and shoulders [but does need the airflow, can't handle stuffiness].	
<b>RELIEVING FACTORS</b>	Hot bath Tablet if needed Massage	

**The Keele Generic Condition Screening Tool**

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

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

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

Not at all

  
0

Slightly

  
0

Moderately

  
0

Very much

  
1

Extremely

  
1
**Score: 2/5**



## **Physical Examination**

### **Observation:**

Increased tone paraspinal neck and upper traps  
Neck crease marked C5/6

### **Functional demonstration of most problematic movement, if applicable:**

Nil, not one

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

- i. Cervical [all pull/pain eases quickly on return to neutral]
  - a. Flexion: 2/3 Pain upper Tx
  - b. Extension 1/2 pain mid/lower Cx
  - c. Right rotation: pull opposite side 2/3 to EOR
  - d. Left rotation: pull opposite side 2/3 to EOR
  - e. Right side flexion: pull opposite side 2/3 to EOR
  - f. Left side flexion: pull opposite side 2/3 to EOR
  
- ii. Thoracic
  - a. Flexion: EOR pulls Lx
  - b. Extension: EOR pulls mid Tx
  - c. Right rotation: pain mid Tx EOR [R more than L]
  - d. Left rotation: pain mid Tx EOR
  
- iii. Shoulder
  - a. Flexion EOR: bilateral pull yoke and shoulder
  - b. Abduction as above
  - c. Hand behind neck
  - d. Hand behind back: R negative (thumb to T5). L pulls upper traps and shoulder stiff (thumb to T9) with elevation and anterior tilt of scapula.

### **Palpation:**

PA C2 – C4 local pain stiff

PA C5 C6 local pain more mobile segment

PA C7 locally painful stiff

PA T1 – T4 stiff not painful

Unilateral PA: Cx locally painful upper Cx C12 and C5/6 especially; also tender throughout Cx spine.

In2creased tone marked upper traps, lev scap, paraspinal ext Cx bilat.

## Appendix 8: Subject Workstation Measurement

### Workstation Adjustment – Subject 1

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)	470
Habitual VDT height (top of monitor to floor) VDT(h)	1360
Table height	740
Elbow to chair height	250
Eye to chair height	720

The following can now be calculated:

Measurement	PC-SAFE calculation	mm
Elbow height	Table height + 25 mm	765
Adjusted chair seat height SH(a)	Elbow height - Elbow to chair height	515
Adjusted VDT height VDT(a)	Eye to chair height + chair seat height	1235

## Appendix 9: 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
-----	----

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 10: Phase End Questionnaire

### *Phase End Questionnaire*

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

Dear \_\_\_\_\_ Date: \_\_\_\_\_

<p><b>1. Have you been absent from work in the past 4 weeks?</b> If yes, which dates were you absent?</p>	Yes	No
<p><b>2. Have you received any treatment (such as physiotherapy, chiropractic or other) for your neck or upper back pain over the past 4 weeks?</b> If yes, what treatment have you received? What effect has this treatment had?</p>	Yes	No
<p><b>3. Have you made any adjustments to your workstation over the past month?</b> If yes, please describe the adjustments that you have made.</p>	Yes	No
<p><b>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.)</b> If yes, please specify</p>	Yes	No

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

## Appendix 11: Completed Exit Questionnaire

### Exit Questionnaire

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

Dear [REDACTED]

Date: 28 JUNE 2014 WITH REFERENCE TO END PHASE 3.

1. Have you been absent from work in the past 4 weeks? If yes, which dates were you absent?	Yes	No <input checked="" type="checkbox"/>
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 <input checked="" type="checkbox"/>

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 <input checked="" type="checkbox"/>			
<table border="1"> <tr> <td>Back to my original settings</td> <td>Back to the adjusted settings for the study</td> <td>Other change</td> </tr> </table>	Back to my original settings	Back to the adjusted settings for the study	Other change		
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.) If yes, please specify:	Yes	No <input checked="" type="checkbox"/>
5. Has the nature of your work changed over the past 3 months? If yes, please specify:	Yes	No <input checked="" type="checkbox"/>
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 <input checked="" type="checkbox"/>

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 <input checked="" type="radio"/>
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: <b>DEATH IN FAMILY</b>	Yes <input checked="" type="radio"/>	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 <input checked="" type="radio"/>
11. Have there been any changes in your general health in the past 3 months? If yes, please specify:	Yes	No <input checked="" type="radio"/>
12. Have you changed your mattress in the past 3 months? If yes, please specify:	Yes	No <input checked="" type="radio"/>
13. Have you changes your pillow in the past 3 months? If yes, please specify:	Yes	No <input checked="" type="radio"/>
14. Have you changed your glasses prescription in the last 3 months? If yes, please specify:	Yes	No <input checked="" type="radio"/>

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

	Disagree 0	Agree 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

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 checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
0	0	0	1	1

Score 0/5

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