The effect of a thoracic spine postural cushion on seated spinal posture in asymptomatic participants in the eThekwini Municipality.

By

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Durban University of Technology

I, Kerry-Lee Young, do hereby declare that this dissertation is representative of my own work in both conception and execution (except where acknowledgements indicate to the contrary)

_	11/06/2020
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DEDICATION

It is with deep gratitude that I dedicate this dissertation to my parents: Victor and Janet Young. This would not have been possible without your unwavering love, support and generosity. I will always be deeply grateful for your continuous encouragement and the sacrifices you have made to get me to this point of my greatest achievement in my career thus far. Thank you.

I love you both dearly.

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ABSTRACT

Background: Back pain has been associated with prolonged sitting. There have been several postural aids designed to help alleviate this pain, mostly lumbar support cushions. Few studies have assessed how a thoracic support cushion could affect posture.

Objective: The purpose of the study was to determine the effect of a thoracic spine postural cushion on seated posture, during a reading task initially, then after one and two minute intervals, in terms of subjective (comfort rating) and objective outcomes (angle of forward head posture, head translation, head force, hip translation and Posture Number™), as recorded by Posture Pro.

Methods: The study was a quantitative observational pre-test post-test design which recruited adult participants between the ages of 18 and 45, of any race or gender, who were asymptomatic in terms of back/neck pain and resided in the eThekwini Municipality. All participants were allocated to one group, with multiple objective measures and a subjective measure of comfort. Thus, they were their own control, i.e. each participant's posture was assessed with and without the RidgeBack™ cushion, while carrying out a reading task on a computer screen. Photographs were taken of participants at zero minutes (baseline), one minute and two minutes and their posture was automatically measured by software on Posture Pro.

Results: Significant improvements in posture were found in all measures (forward head position, head translation, head force and Posture Number™) at baseline ($p < 0.001$), one minute ($p < 0.001$) and two minutes ($p < 0.001$) with the cushion compared to without the Ridgeback™. Hip translation showed no statistically significant change at baseline ($p = 0.428$), one minute ($p = 0.055$) or two minutes ($p = 0.577$) during the study. Intra-group analysis showed that the improvements in posture were maintained over the study duration when the cushion was utilised. When assessing subjective comfort of participants, there was higher comfort rating when using the cushion, but this finding was not significant ($p = 0.071$).

Conclusion: This study showed that the RidgeBack™ thoracic support cushion resulted in an improved posture when compared to no cushion. Further studies are required in symptomatic populations and over a longer duration to determine the impact of the cushion on back pain caused by sitting.

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LIST OF ABBREVIATIONS

BMI	**:**	Body Mass Index
CDC	**:**	Chiropractic Day Clinic
cm	**:**	centimetres
DUT	**:**	Durban University of Technology
FHP	**:**	forward head posture
HF	:	head force
Hip_T	**:**	hip translation
HT	**:**	head translation
IREC	**:**	Institutional Research Ethics Committee
kg	**:**	kilogram
M	**:**	mean
m	**:**	metres
mm	**:**	millimetres
MOU	**:**	memorandum of use
N	:	total number of participants
n	**:**	number of participants
p	**:**	*p*-value
PN	**:**	Posture Number™
™	**:**	trademark
WC	**:**	with cushion
WOC	**:**	without cushion
°	**:**	degrees
%	**:**	percentage
>	**:**	greater than

< : less than

= : equal to

(±SD) : standard deviation

DEFINITIONS

Arthritides:

Diseases (such as rheumatoid arthritis and inflammatory arthritis) that affect joints, including its surrounding tissue, and usually causes pain, swelling and stiffness resulting in a decrease in full range of motion of such joint (Suhrbier and Mahalingam 2009).

Asymptomatic:

There are no showing symptoms (Boulet 2003).

Ergonomics:

Defined as the study of how a human interacts with their work environment or space (Sirajudeen *et al.* 2017).

Forward head posture:

The forward translation of the head which is a commonly assumed postural pattern (Fortner *et al.* 2018).

Hyperkyphosis:

The abnormal excessive convex curvature of the thoracic spine leading to joint dysfunction and pain (Magee 2013).

Hyperlordotic:

The abnormal excessive concave curvature of the lumbar spine leading to joint dysfunction and pain (Magee 2013).

Hypertonicity:

An increase in muscle tone which may vary in severity leading to muscle rigidity (Schils *et al.* 2015).

Kyphosis:

The natural convex curvature of the thoracic spine which could become excessive and termed hyperkyphotic (Magee 2013).

Musculoskeletal:

Tissue that makes up the body's muscle and skeletal system which includes bone, cartilage, synovium, ligaments and muscles (Dehghan *et al*. 2013).

Posture:

The collective arrangement of all body parts during any given time (Magee 2013).

Translation:

The forward or backward movement along an axis (Plaugher 1993).

Chapter One

Introduction

1.1 INTRODUCTION TO THE STUDY

Human beings express different postures during various tasks or movements, such as standing, sitting, squatting or lying down (Koskelo *et al*. 2007). While standing posture is important, a focus on seated posture and factors influencing seated posture will be highlighted in this study.

Prolonged seated postures are associated with musculoskeletal pain, particularly in the back (Stenlund *et al*. 2014). Office workstations are known to dominate the modern working world, thus resulting in employees being seated at their desks for most of their time during the working day (Toomingas *et al.* 2012). This sedentary type lifestyle can cause an array of negative effects on the body, including poor posture and back pain (Carcone and Keir 2007), therefore highlighting the importance of assessing posture during periods where it is maintained over long periods of time, for example, seated at an office desk or workstation (Stenlund *et al*. 2014). Incorrect sitting for long periods of time leads to muscle fatigue and may cause muscle hypertonicity. This can manifest as postural alterations such as forward head posture and rounded shoulders, which increases the thoracic kyphosis and may result in thoracic spinal pain (Singla *et al*. 2017). Thus, finding suitable and effective mechanisms in order to reduce such risks that lead to back pain during prolonged periods of sitting, is important (Grondin *et al.* 2013).

There are many studies (Grondin *et al*. 2013; van Duijvenbode *et al*. 2008; Aota *et al*. 2007) investigating lumbar support cushions showing that they alleviate low back pain. Little attention has been paid to supports for other areas of the spine. A prototype thoracic postural cushion called RidgeBack™, was developed to aid sitting posture in car seats and office chairs. Introductory case reports claim that the cushion decreases neck, thoracic and lumbar spine pain by maintaining correct seated posture. In order to substantiate these claims, this study aims to independently assess the effect of the thoracic spine postural cushion on seated posture using the Posture Pro software. Thereby providing the manufacturer and the public with evidence for or against such a cushion as a postural aid.

1.2 AIM AND OBJECTIVES

1.2.1 Aim of the study

The aim of the study is to determine the effect of a thoracic spine postural cushion on seated posture, during a reading task initially, then after one and two minute intervals, in terms of subjective (comfort rating) and objective outcomes (angle of forward head posture, head translation, head force, hip translation and Posture Number™), as recorded by the Posture Pro software.

1.2.2 Study Objectives

The objectives of the study were:

1) To determine seated posture without the RidgeBack™ cushion initially then at one and two minutes into a reading task in terms of the objective's outcomes.

2) To determine seated posture with the RidgeBack™ cushion initially then at one and two minutes into a reading task in terms of the objective's outcomes.

3) To compare the objective measurements (initial, one and two minute) obtained with and without the cushion.

4) To determine the subjective comfort rating of participants while performing the reading task with and without the RidgeBack™ cushion.

1.3 HYPOTHESIS

The Null Hypothesis states that:

1. There will be no statistical significance ($p > 0.05$) difference in the angle of forward head posture between 0 minutes, 1 minute and 2 minutes, compared with and without the thoracic spine postural cushion.

2. There will be no statistical significance ($p > 0.05$) difference in head translation between 0 minutes, 1 minute and 2 minutes, compared with and without the thoracic spine postural cushion.
3. There will be no statistical significance ($p > 0.05$) difference in head force between 0 minutes, 1 minute and 2 minutes, compared with and without the thoracic spine postural cushion.
4. There will be no statistical significance ($p > 0.05$) difference in Posture Number™ between 0 minutes, 1 minute and 2 minutes, compared with and without the thoracic spine postural cushion.
5. There will be no statistical significance ($p > 0.05$) difference in hip translation between 0 minutes, 1 minute and 2 minutes, compared with and without the thoracic spine postural cushion.
6. There will be no statistical significance ($p > 0.05$) difference between comfort with and without the thoracic spine postural cushion.

The Alternate Hypothesis states that:

1. There will be statistical significance ($p < 0.05$) difference in forward head posture between 0 minutes, 1 minute and 2 minutes, compared with and without the thoracic spine postural cushion.
2. There will be statistical significance ($p < 0.05$) difference in head translation between 0 minutes, 1 minute and 2 minutes, compared with and without the thoracic spine postural cushion.
3. There will be statistical significance ($p < 0.05$) difference in head force between 0 minutes, 1 minute and 2 minutes, compared with and without the thoracic spine postural cushion.
4. There will be statistical significance ($p < 0.05$) difference in Posture Number™ between 0 minutes, 1 minute and 2 minutes, compared with and without the thoracic spine postural cushion.

5. There will be statistical significance ($p < 0.05$) difference in hip translation between 0 minutes, 1 minute and 2 minutes, compared with and without the thoracic spine postural cushion.
6. There will be statistical significance ($p < 0.05$) difference between comfort with and without the thoracic spine postural cushion.

1.4 DELIMITATIONS

This study was conducted on asymptomatic participants as pain, disability and disease can affect a person's seated posture (Miller 2004).

The inclusion criteria for this study were limited to asymptomatic participants between the ages of 18 and 45 years. This age range limited the inclusion of those with spinal degeneration, diagnoses of osteoporosis and athritides (Katzman *et al*. 2011).

Due to the limited nature of the study regarding time and resources, specific choices had to be made regarding the various tools used for the study. Posture Pro software was chosen as the postural measurement system, and multiple measurements were obtained using this software. Furthermore, the study was designed around the use of one standard office chair.

1.5 FLOW OF DISSERTATION

Chapter one: This chapter has detailed the study, aims, objectives and hypothesis/delimitations are outlined in this chapter.

Chapter two: This chapter includes the literature review, which provides the reader with a summary of normal posture, incorrect posture, the factors effecting posture and devices used to maintain ergonomic posture at a workstation in an office environment.

Chapter three: This chapter will outline and explain in detail the methodology used to obtain the data using the aims and objectives in the study. The study design, recruitment and sample characteristics, methods and objective measurement through the use of equipment, data analysis and ethical issues are described in detail.

Chapter four: This chapter will present the results of this study.

Chapter five: This chapter will provide the analysis and discussion of the results relative to the current literature.

Chapter six: This chapter will conclude the study making recommendations for future research and identifying any limitations associated with the study.

Chapter Two

Literature Review

2.1 INTRODUCTION

Spinal support cushions have been used for a number of years with success showing decreased pain and an increase in comfort levels during prolonged periods of sitting. While lumbar support cushions are the most common, thoracic spine postural cushions and their effect on seated posture require further investigation (Gruevski *et al*. 2016).

This chapter provides the reader with an overview of posture, the different types, the factors effecting it and devices used to ergonomically correct it. The sources used to find such data were as follows: the library at Durban University of Technology, Summon, PubMed, Google Scholar, and Medline. The key phrases used are as follows: sitting posture, standing posture, measuring standing posture, normal posture, thoracic cushion, lumbar supports, factors effecting posture, chair ergonomics, and musculoskeletal pain.

2.2 POSTURE

The human body is held upright by the strength and support of the vertebral column which extends from the base of the occiput down to the pelvis. It offers not only support to stand and sit upright, but protects the spinal cord while allowing full range of motion to the trunk (Stenlund *et al*. 2014). The spine is categorised into four regions: cervical, thoracic, lumbar and sacral. Each of these regions form a natural curvature throughout the spine from cervical lordosis to thoracic kyphosis and lumbar lordosis. Together, they form an “S-shape” when viewed laterally (Cramer and Darby 2014). This curvature allows an individual to move and carry out daily functions with ease. Daily activities are affected when the spinal column undergoes functional or structural changes leading to abnormal movements and functions resulting in pain, dysfunction and disease (Katzman *et al*. 2016).

Human beings express different postures during various tasks or movements, such as standing, sitting, squatting or lying down (Koskelo *et al*. 2007). Although individuals have different postures, the Posture Committee of the American Academy of Orthopaedic Surgeons defined that "good posture" is present when the body's functions and structures are supported at its optimum. This is when there is homeostasis between the state of the muscles and skeleton during working or resting, thus protecting the body against abnormal functions which result in injury (Grimmer-Somers *et al*. 2008).

2.2.1 Standing Posture

Human erect posture is assessed by viewing anterior, posterior and lateral aspects of the body. Lateral assessment of posture is observed using the lateral line of reference – a line dividing the body into anterior and posterior halves (Magee 2013). In the standing position, the line should run from the earlobe, down through the acromion process, the greater trochanter of the femur down to pass slightly anterior to the lateral malleolus (Magee 2013). This is when the cervical, thoracic and lumbar spine are in neutral and this correct alignment is achieved when there is the least amount of strain exerted onto each joint (Brink *et al*. 2015). This means that if the posture is correct, there should be a minimal amount of muscle activity required to maintain the erect position due to an equilibrium (Magee 2013).

The lateral line of reference is expected to run vertically downwards and pass congruently through specific anatomical points on the body, as seen in Figure 2.1. If all points meet on this line, then the individual is considered to have a normal posture (Gross *et al*. 2015). Figure 2.1 further illustrates three common postural alterations (B to D).

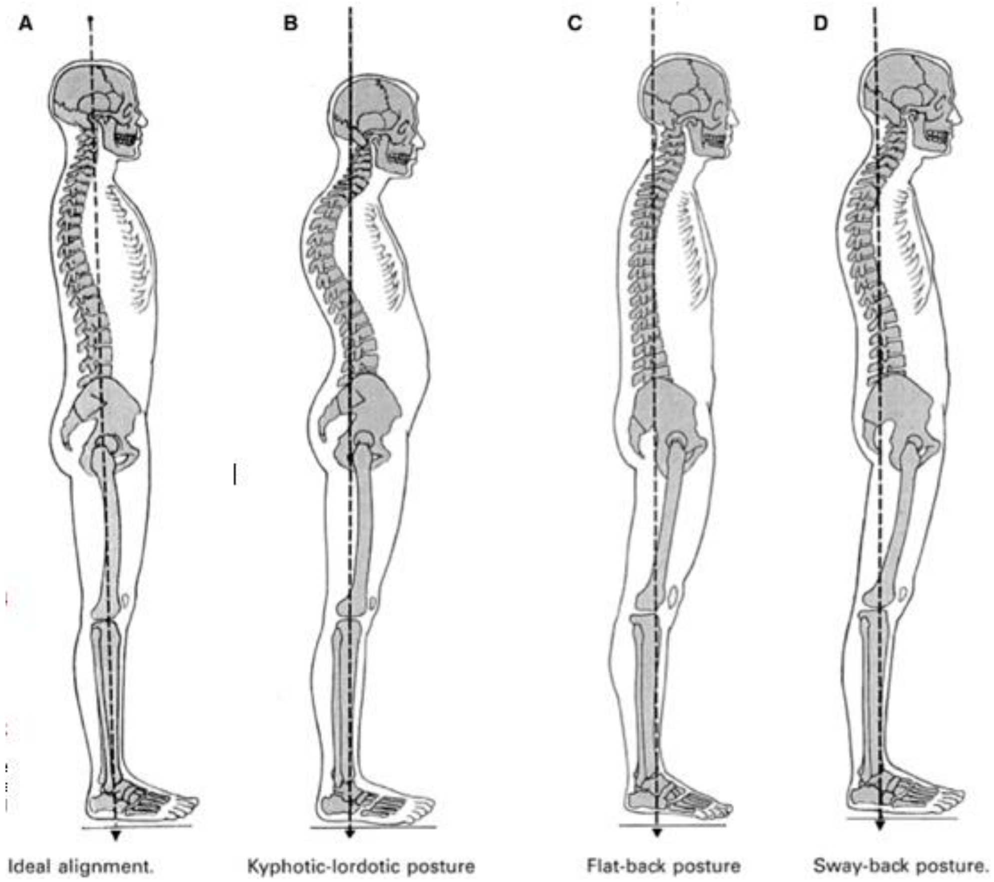


Figure 2.1: A diagram showing ideal posture vs posture deviations (Kendall 2005)

While there is no consensus on ideal posture, a good posture should maintain normal spinal curvatures (Stenlund *et al*. 2014), thereby keeping joints in a neutral position, avoiding tissue strain which could lead to musculoskeletal pain (O'Sullivan *et al*. 2012). Postural deviations have been associated with musculoskeletal pain (Brink *et al*. 2015), and assessing posture is therefore an important component of the musculoskeletal examination for chiropractors, physiotherapists and other practitioners who treat musculoskeletal pain. Prolonged deviations in posture lead to abnormal muscle lengthening or adaptive shortening which results in a decrease of efficiency when carrying out normal daily activities. This decrease in efficiency may lead to fatigue, pain and injury, further debilitating an individual (Brink *et al*. 2015; Gross *et al*. 2015).

2.2.2 Sitting Posture

Besides examining posture in the erect position, it is necessary to assess it in positions that the patient may assume for long periods of time (Stenlund *et al*. 2014). For example, office workers assume a seated position for up to 85% of their working hours during the day (O'Connell *et al*. 2015), thus necessitating the need for the seated office desk postural assessment.

In the seated position, like the standing examination, deviations in the sagittal plane are assessed using the using the lateral line of reference. In the seated position the lateral line of reference runs though the earlobe, down through the acromion process and ends just posteriorly to the greater trochanter of the femur (Straker *et al*. 2009). Seated posture eliminates any discrepancies in alignment caused by lower extremity abnormalities and there are less points to consider while seated when focusing on spinal alignment (Magee 2013; Straker *et al*. 2009).

Most adults spend at least half their day seated and due to the adaptation of poor sitting postures, human health risks such as pain, injury and stress continue to rise, increasing the risk of future chronic spinal abnormalities (Qian *et al*. 2018 and Uffelen *et al*. 2010), highlighting the importance of good posture and even distribution of pressure while seated (Grimmer-Somers *et al*. 2008).

Poor sitting postures do not only negatively affect the health of an individual, but also poses the risk of financial strain due to sought after medical attention, resulting in an increased absenteeism from work and a decrease in work productivity (Wieser *et al*. 2011). As employees are increasingly found working in office environments, it is critical to emphasise the importance of focusing on the identification and improvement of human sitting posture (O'Connell *et al*. 2015). Figure 2.2 below shows deviations in seated postures.

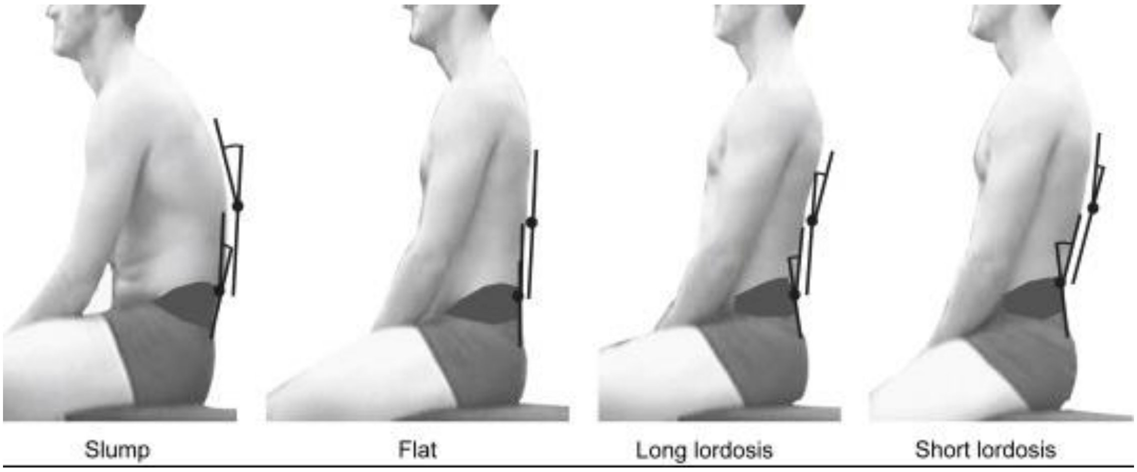


Figure 2.2: Photographic images showing deviations in seated postures (Claus *et al*. 2008)

Prolonged seated postures are associated with musculoskeletal pain, particularly in the back (Stenlund *et al*. 2014). Incorrect sitting for long periods of time leads to muscle fatigue and may cause muscle hypertonicity. This can manifest as postural alterations such as forward head posture and rounded shoulders, which increases the thoracic kyphosis and therefore thoracic spine pain (Singla *et al*. 2017).

Although there are fewer studies done on thoracic spine pain compared to cervical and lumbar spine pain, Briggs *et al*. (2009) stated that thoracic spine pain is a common form of a debilitating dysfunction in the work place which affects a large amount of the population. Further studies are pertinent in order to assist individuals with thoracic spine pain to increase the knowledge around the importance of prevention and management (Briggs *et al*. 2009).

2.2.3 Factors Affecting Posture

There are two main categories responsible for postural irregularities affecting the way in which we sit or stand: structural and positional factors (Magee 2013). Although anatomical factors may be considered a third, they fall under each of the two categories and include: ligaments (increased laxity), muscles and fascia (contracture/spasm/tightness), bone (trauma/degeneration/abnormalities), joint position and mobility, nerve transmission and pelvic angle (posterior/anterior) (Magee 2013).

2.2.3.1 Structural factors

Structural factors are due to abnormalities present in the bony structure. While patients with structural factors may respond to correct posture instruction and exercises, correction is unlikely without surgery (Ogihara *et al*. 2013). Structural factors include structural deformities (such as structural scoliosis, Scheuermann's kyphosis and spondylosis), congenital abnormalities (like Spina bifida and Klippel-Feil syndrome), trauma, disease and developmental issues (Bialek and Kotwicki 2009; Shimizu *et al*. 2019).

2.2.3.2 Positional Factors

Positional factors are usually easier to correct as they involve changes to posture due to an individual's environment or habit. Examples of positional factors are:

- Height embarrassment, whereby a tall person slouches, for example. This causes abnormalities leading to muscle imbalances, contractures and pain (McLaren and Parrott 2018).
- Muscle contractures due to injury or as a result of a rapid growth spurts when muscles do not adapt quick enough to the bone growth. When occurring around the hip and pelvis, it leaves the iliopsoas and hamstrings muscles hypertonic leading to a hyperlordotic lumbar curve (Kim *et al*. 2014).
- Respiratory conditions such as asthma and emphysema, which may decrease the proper functioning of the diaphragm and contribute to positional factors affecting posture. Respiratory conditions increase the exertion on the ribcage and thoracic vertebrae, and it is believed that when the diaphragm and abdominal muscles work together, they aid in spinal stabilisation (Szczygiel *et al*. 2018).
- Pain caused by sciatica or other nerve root entrapments, which leads to compensation and antalgic postures possibly resulting in scoliosis – a lateral curvature of the spine (Ploumis *et al*. 2011) – or alterations in muscle balance affecting posture.

- Excessive weight due to obesity or pregnancy, which can lead to hyperlordotic postures and a decrease in proprioception leading to posture changes (Di Giulio *et al*. 2009).
- Postural habits, the most common cause of incorrect posture, resulting from prolonged periods of sitting or standing leading to the inability to maintain good posture resulting in weak, inflexible muscles unable to adapt to the encountered challenges, leading to slouching and rounded shoulders, especially while seated (Magee 2013).
- Ergonomic environment, which is one of the most largely known factors contributing to poor posture and musculoskeletal disorders. Poorly designed ergonomically environments affect seated postures which ultimately results in a decline in performance in the work place. These factors result in preventable stress on the head, neck and trunk of an individual (Li and Buckle 1999). Although human-chair interaction may differ between genders, body types and body builds, sitting for long periods of time leads to risks of fatigue and altered posture, highlighting the importance of prevention and correction using ergonomics (Stenlund *et al*. 2014).

Correction of the above-mentioned postural changes include the use of manual therapy to strengthen weak muscles, stretch tight muscles and rectify behavioural patterns (Magee 2013).

2.2.4 Measuring Posture

2.2.4.1 Observational Methods

Most methods of measuring posture in clinical practice and the work place rely on observational checklists which are considered to be the most effective and reliable (Baker *et al*. 2013). These checklists may fail in reliability if an assessment is carried out by an individual with an untrained eye, resulting in variations (Schreuer *et al*. 2009). Table 2.1 shows an example of an observational checklist designed by Paul Bohr (2000) of Washington University School of Medicine which was used as a template in this study.

Table 2.1: Example of a Workstation Observational Checklist (Bohr 2000)

WORK AREA CONFIGURATION	YES	NO	COMMENTS
1. Top of screen slightly below eye level?			
2. Monitor directly in front of worker?			
3. Distance to monitor approximately 18″?			
4. Keyboard at correct height?			
5. Keyboard aligned with body?			
6. Keyboard aligned with monitor?			
7. Keyboard tray is available?			
Keyboard tray is used?			
8. Lumbar curve is supported by backrest?			
9. Chair is adjustable?			
10. Edge of seat about 2″ behind bend of knee?			
11. Seat height allows thighs to be parallel with floor?			
12. Foot rest available to support feet?			
Footrest is used?			
13. Operation of mouse requires reaching?			
14. Mouse tray is available?			
Mouse tray is used?			
15. Location of copy requires rotating to see?			
16. Screen brightness appropriate for work area lighting?			
17. Tilt of monitor is appropriate for worker and area?			
18. Glare on monitor is apparent?			
19. Telephone within easy reach?			
20. General lighting of work area is appropriate?			
21. Noise/distractions in work area are present?			
22. Temperature of work area is appropriate?			
WORKER POSTURES	YES	NO	COMMENTS
1. Thighs parallel to the floor?			
2. Feet supported on floor or footrest?			
3. Low back supported by backrest?			
4. Arms relaxed at side & perpendicular to floor?			
5. Elbows bent at 90° so forearms are parallel to floor?			
6. Wrists in neutral for flexion & extension?			
7. Wrists are deviated (radially or ulnarly)?			
8. Shoulders are relaxed, not elevated?			
9. Neck in neutral (i.e. chin is level)?			
10. Neck flexed to hold phone?			
11. Head rotated?			
12. Trunk rotated?			

2.2.4.2 Photogrammetry Methods

Another form of postural assessment is computer software programmes that are designed to analyse posture from photographs (Herbert-Losier *et al*. 2018). Photographic use for postural assessment was found to be reliable by Lau *et al*. (2010). The system used in this study was the Posture Pro software, a computerised software programme, which calculates the sum of postural deviations of each participant. It is a digital system that provides the ability to quantitatively document a participant's posture by measuring head force, forward head posture, head translation, hip translation and Posture Number™. The closer these objective measures are to zero, the closer an individual's posture is to be considered as ideal or normal posture (Herbert-Losier *et al*. 2018). This measurement was done by taking an anterior and lateral photograph of an individual sitting and importing the photograph into the Posture Pro software which automatically calculated the measurements after manually matching up the anatomical markers on the individual on the Posture Pro software. Both Herbert-Losier *et al*. (2018) and Senthil *et al*. (2018) stated that the Posture Pro software was found to be a reputable and reliable form of posture assessment which benefitted many patients who sought help from health care professionals.

2.3 SITTING ERGONOMICS

Ergonomics is defined as the study of how a human interacts with their work environment or space (Sirajudeen and Siddik 2017). An ergonomically correct workspace or workstation is achieved when the job or task is designed to fit the worker rather than forcing the worker to physically fit the task (Heuch *et al.* 2017). An increase in work efficiency and comfort, with a decrease in health and safety risks are factors seen when practicing good ergonomics (Marcus *et al*. 2002).

2.3.1 Musculoskeletal Pain and Sitting

There is a high prevalence, between 61-70%, of musculoskeletal pain present in office workers, annually (Pereira *et al.* 2016). A direct correlation between the rise in computer work and musculoskeletal pain has been reported (Waersted *et al.* 2010), and together with the increasing demands of the modern working world mean that sedentary lifestyles are on the rise (Buckley *et al.* 2015).

The majority of the world's population have experienced spinal pain or discomfort at some point in their lives (Hoy *et al.* 2014), with office workers having a greater one year prevalence of neck and back pain than the general population due to prolonged seated postures on a regular basis (Chiu *et al.* 2002). Guo *et al.* (2016) also reported that back pain has been commonly recorded in conjunction with extended periods of sitting. In a study done by Ayanniyi *et al.* (2010), 300 questionnaires were distributed amongst computer workers and it was recorded that 86% of participants had experienced musculoskeletal pain, with the highest prevalence reported for neck pain (>60%), thoracic spine pain (>50%) and low back pain (>50%).

Rodrigues *et al.* (2017) researched office workers' experiences with musculoskeletal pain over a three months period and found that those who suffered had poorer ergonomically sound work stations, particularly pertaining to their office chairs – incorrect chair height, arm rest and back rest – had higher rates of reporting musculoskeletal pain, indicating that work place and office setup play a major role in neck and back pain prevalence (Pereira *et al.* 2016).

Research shows extended periods of sitting contributes to back pain, and particularly the adopted work posture while carrying out tasks is also a significant causative factor (Heuch *et al.* 2017).

A good seated posture maintains the lumbosacral spinal curves, as shown in Figure 2.3, as well as thoracic and cervical spinal curves (Astfalck *et al.* 2010).

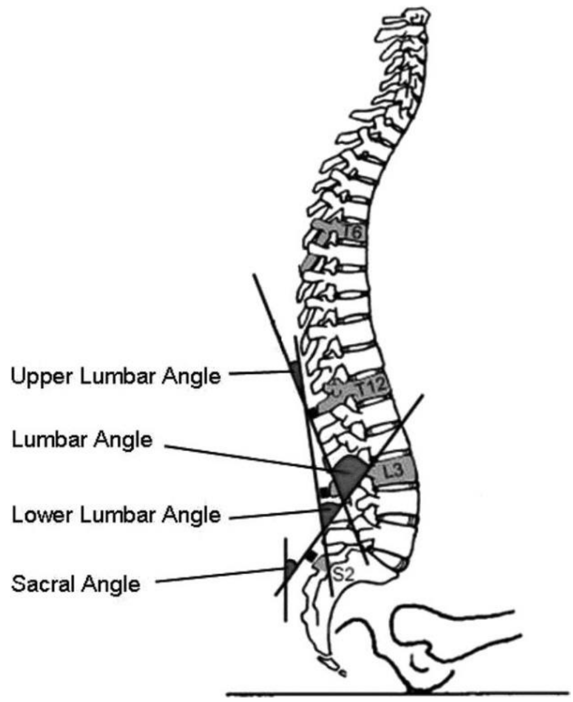


Figure 2.3: A diagram showing correct lumbosacral spinal curves during good posture (Astfalck *et al.* 2010)

A good seated posture keeps the joints in a neutral position during any task to prevent strain on the joints and supportive muscle tissues which would otherwise lead to musculoskeletal disorders (O'Sullivan *et al.* 2012) – in other words, maintaining an optimum state of musculoskeletal balance (Scannell and McGill 2003).

It can be concluded that although the body can adapt to an individual's work environment initially, there will be long term effects if the work environment is ergonomically deficient (Sirajudeen *et al.* 2017). Pain, stress, decrease in work execution, poor quality of work and an increase in absenteeism are factors which result from poor sitting habits (Connelly *et al.* 2006), thus, highlighting the importance of chair ergonomics and posture in office workers.

2.3.2 Workstation Ergonomics

Good chair ergonomics plays a major role in maintaining correct seated posture (Kroemer and Kroemer 2001). It has been estimated that 70-85% of the hours worked by individuals who are working in offices are seated during their day, thereby highlighting the great importance to correct an individual's ergonomic seated posture by ensuring the correct chair and office setup is utilised (O'Connell *et al.* 2015).

The various factors to consider in workplace ergonomics are shown in Figure 2.3 below. Ideal workstation ergonomics, as referred to by Workineh and Yamaura (2016), can be described as such: An ideal office chair, depending on an individual's height, has a seat (c) height of 44-52cm, backrest (b) height of 51-58cm, backrest (b) inclination of 104-120˚, has arm rests (d) and is sturdy on the ground with four legs (Kroemer and Kroemer 2001).

Although a good office chair is important, a good desk and desk setup is equally as necessary to aid in an ergonomically sound workstation (Grandjean 2002). A desk height should comfortably allow an individual to rest their forearms in front of them without hiking the shoulders, a screen (g) height of 90-115cm from the floor where the top of the screen (g) is just below eye level, screen (g) distance from table edge should be 44-96cm, keyboard (e) distance 10-26cm from table edge and keyboard (e) height should measure 70-85cm from the floor (Grandjean 2002).

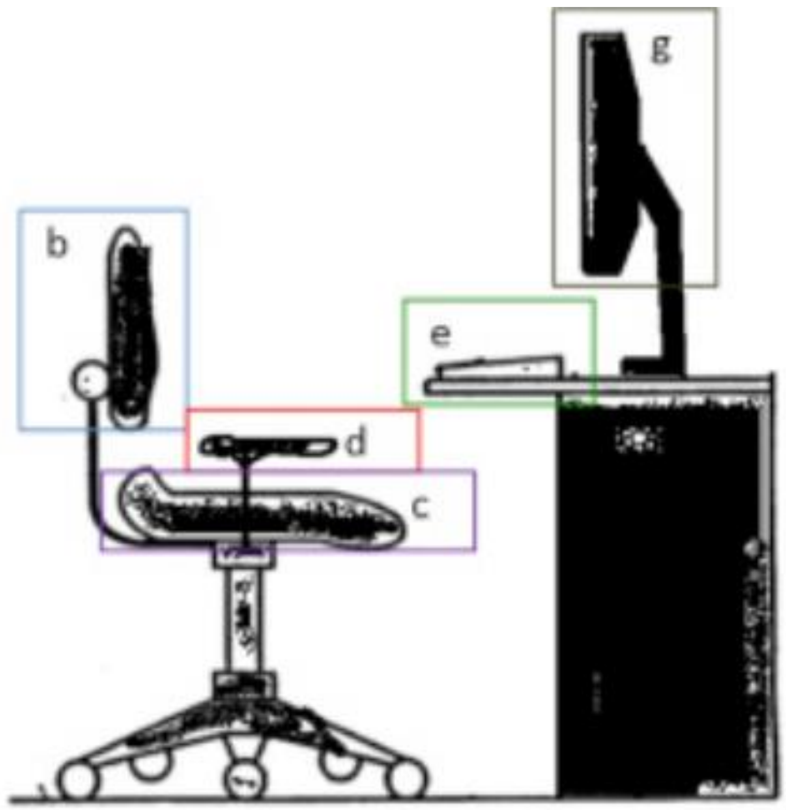


Figure 2.4: Ideal workstation ergonomics (Workineh and Yamaura 2016)

Musculoskeletal disorders, especially back pain are often related to workstation ergonomics occupied by office workers (Girish *et al.* 2012). As shown by many studies (Maaswinkel *et al.* 2014; Lis *et al.* 2007; Li and Buckle 1999), it is evident that the development and formation of musculoskeletal disorders is closely related to poor seated postures. Prolonged periods of sitting with poor posture is often caused by an incorrect design of the workstation or office chair and can easily become second nature causing or enhancing already existent neck or back pain which ultimately leads to change to spinal curves and structures and potential injury (Sonne *et al.* 2012).

When sitting, an individual should sit so that the shoulders are widened, buttocks to the back of the chair seat with the thoracic spine relaxed against the back rest, the femurs hip width apart, the knees at 90 degrees flexion and the ankles roughly in line with the knees, with the feet flat on the floor (Magee 2013) – this will allow minimal strain to the structures of the body.

2.3.3 Ergonomic Postural Correction Interventions

In an attempt to improve seated posture and reduce musculoskeletal pain, Karsh *et al*. (2001), examined 101 studies involving work station interventions and their efficacy to control musculoskeletal disorders. A variety of ergonomic interventions have been implemented including back belts, braces, ergonomic training and lumbar support cushions (Karsh *et al.* 2001) and the novel thoracic postural cushion (Randall 2018).

2.3.3.1 Lumbar Support Devices

A common and easily accessible support device is the lumbar support cushion. Various sizes, shapes and thicknesses of lumbar support cushions have been developed to accommodate for the various types of seats and body sizes (Guo *et al.* 2016). Continuing research into lumbar supports leads to modifications to improve support and decrease the pressure onto the intervertebral discs. Guo *et al.* (2016) designed and developed a 3D lumbar support device, seen in Figure 2.5 below, for motor vehicles to decrease disc stress and improve seated comfort in a study with 50 participants. The lumbar support device had an adjustable thickness and it was concluded that the most comfort and least recorded vertebral disc strain was recorded at a 10mm thickness and when most of the back had contact with the backrest of the chair (Guo *et al.* 2016).

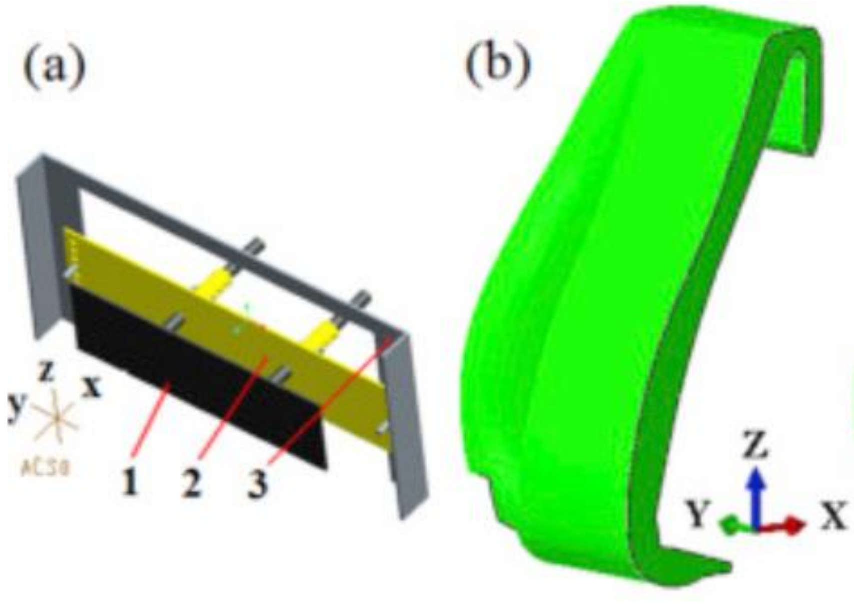


Figure 2.5: Lumbar support device (a) and backrest shape (b) (Guo *et al.* 2010).

Other lumbar support devices under investigation include lumbar belts and braces. A study done by van Duijvenbode *et al.* (2008) involved the review of randomised controlled studies on such lumbar supports. Reviews were done on 7 studies (n=14437) that utilised lumbar support devices as preventative measures, and 8 studies (n=1361) that used these devices for the treatment of low back pain and it was found that there was no conclusive evidence for the use of lumbar belts and braces as a preventative nor a treatment measure for low back pain (van Duijvenbode *et al*. 2008).

Grondin *et al.* (2013) tested a novel lumbar support cushion called Logic Back™ which was rigid in structure (Figure 2.6), and showed favourable results. It included 28 participants who sat on a standard office chair watching a video on a computer screen placed in front of them, while their arms were relaxed on the armrests. Using electromagnetic markers, they found a significant decrease in lumbar spine flattening (p = 0.006) with an increase in the thoracolumbar curvature (p = 0.014). The participants reported increased objective comfort, assessed using pressure mats (p = 0.017), but no increase in subjective comfort levels (Grondin *et al*. 2013).

Figure 2.6: A lumbar support cushion strapped to a standard office chair (Grondin *et al.* 2013)

While lumbar support cushions were reported to increase seated comfort and decrease low back pain, little research has shown if they change posture. A study done by De Carvalho and Callaghan (2012), involving 8 participants, made use of x-rays in order to investigate if lumbar and pelvic postures were changed by lumbar support cushions. A lumbar support prominence was designed for 0cm, 2cm and 4cm thickness and it was found that although the lumbar support cushion increased the lumbar lordosis, there was no increase in the movement of the pelvis. While it was concluded that a lumbar support was healthier for spinal posture, it was important to note that the lack of pelvic movement could potentially increase strain and risk of injury in the lumbopelvic region thus indicating the importance of further research to assess the effects of spinal supports used to improve ergonomics.

2.3.3.2 Thoracic Spine Postural Correction Cushions

While lumbar supports are shown to decrease low back pain (Grondin *et al.* 2013), little attention has been placed on supports for other areas of the spine, such as the thoracic region. Gruevski *et al.* (2016) highlighted the high prevalence of back pain in professional drivers and police officers and conducted a study on 14 participants with a novel thoracic support (Figure 2.7) over a 120-minute period in a lab vehicle simulator. The thoracic support was strapped to the vehicle seat. It was found to increase contact pressure of the thoracic spine significantly ($p = 0.029$). It was reported that the cushion resulted in a slight increase in lumbar spine extension, reportedly less than has been stated in studies investigating lumbar cushions. The authors reported that it resulted in relief of lumbar discomfort and maintained lumbar posture in a healthy range. This study showed that investigation into spinal supports for other areas is promising.

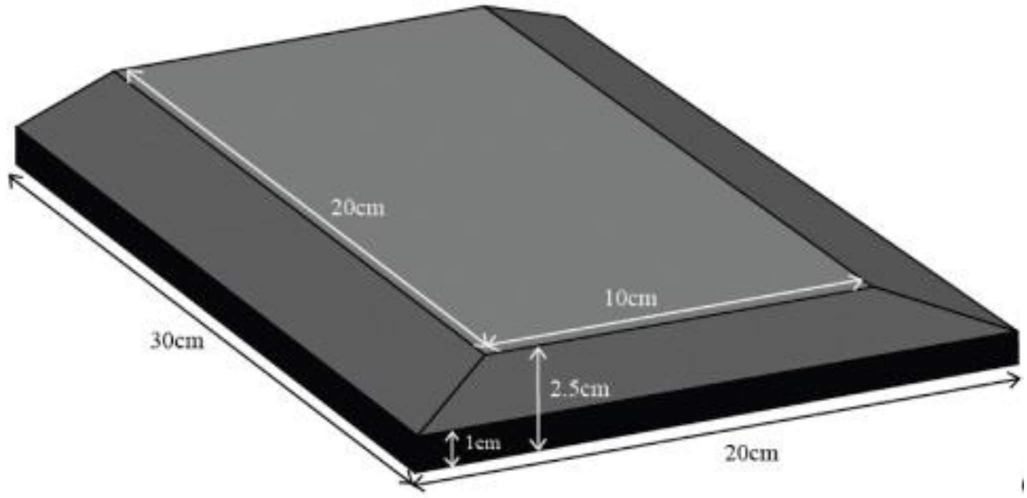


Figure 2.7: A novel thoracic support prototype (Gruevski *et al.* 2016)

The thoracic spine cushion used in this study was developed by a South African entrepreneur and is called the RidgeBack™ (Randall 2018). It is a 315mm by 525mm rectangular cushion made of a main central ridge of high density chipfoam which supports the thoracic spine, surrounded by memory foam for comfort and small hi-density foam wedges for minimal lumbar support (Randall 2018). Randall (2018) reported that the thoracic postural cushion has not formally been tested, but introductory evidence in the form of case reports indicates that it can decrease neck, thoracic and lumbar spine pain while being used in office chairs and car seats. It purportedly does this by correcting an individual's seated posture as seen in the lateral view displayed in Figure 2.9, emphasising the decrease in neck flexion and upright sitting.

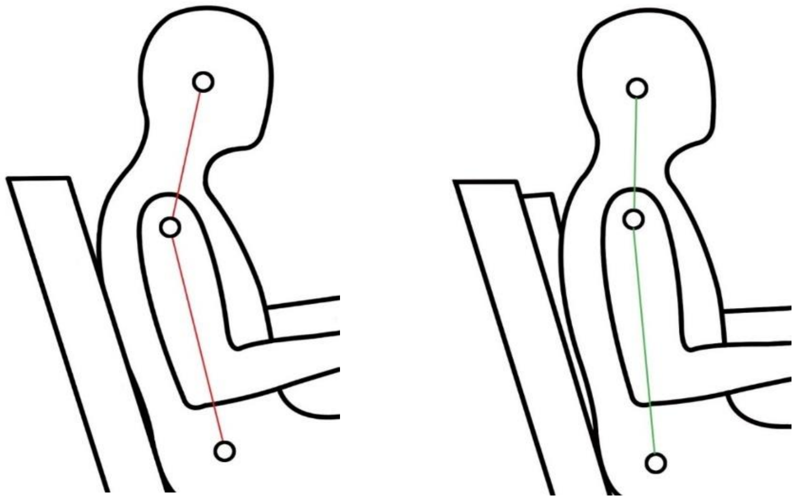


Figure 2.8: Diagram showing a comparison of seated posture without and with RidgeBack™ from a side view (Randall 2018)

In Figure 2.10 a top view shows how the use of the RidgeBack™ cushion corrects seated posture by opening up the chest area and therefore allowing the shoulders to rotate and move backwards.

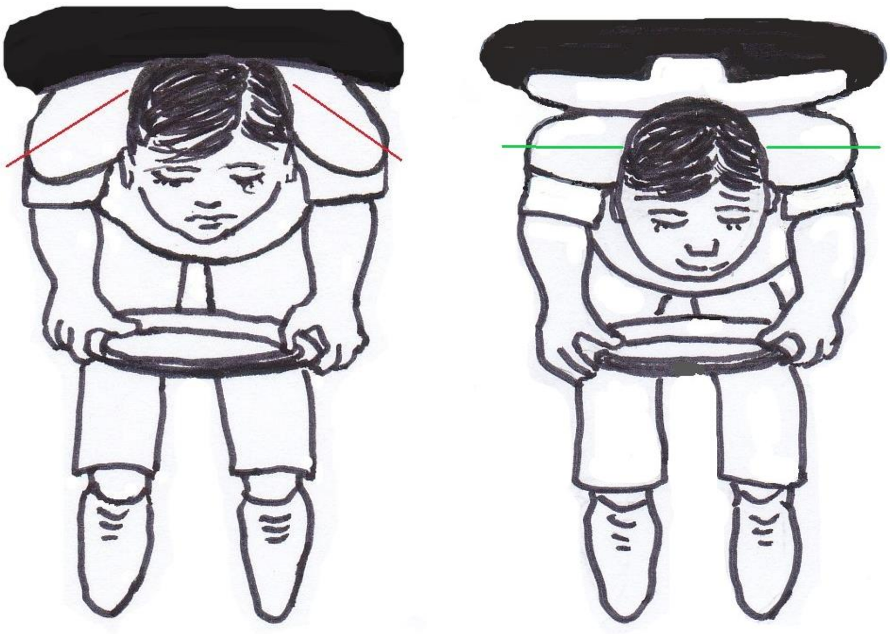


Figure 2.9: Diagram showing a comparison of seated posture without and with RidgeBack™ from a top view (Randall 2018)

In order to substantiate these claims by researchers, this study was aimed to independently assess the effect of the thoracic postural cushion on seated posture and comfort levels, providing the manufacturer and the public with evidence for or against such cushion as a postural aid.

Chapter Three

Methodology

3.1 INTRODUCTION

This chapter details the methods used to conduct this study. In addition, the well-being and ethical considerations of the participants are described.

3.2 STUDY DESIGN AND PERMISSION

The study was a quantitative observational pre-test post-test design. Observational studies allow the examination of participants during data collection without the risk of interference and affecting the result outcome (Pandis 2014). Pre-test post-test designs are widely used, and allow for comparison from measures taken before an intervention to those taken after (Salim *et al.* 2007), thus making this design suitable to this investigation.

This study was approved by the Institutional Research Ethics Committee (IREC) of Durban University of Technology (DUT) (IREC 087/19, Appendix A). This study was conducted at the DUT Chiropractic Day Clinic (CDC) after obtaining permissions from the Research and Postgraduate Support Directorate (Appendix B) Clinic Director (Appendix C), IREC and the cushion developer (Appendix D).

3.3 STUDY POPULATION

The study recruited adult participants between the age of 18 and 45, of any gender or race, who were asymptomatic in terms of back/neck pain and resided within the eThekwini Municipality.

3.4 SAMPLE STRATEGY

3.4.1 Sample Size and Allocation

In order to ascertain the sample size for this project, 5 volunteers were utilised in a pilot test to gather data to be able to determine the effect size. A biostatistician utilised G*Power version 3.1 (Faul *et al.* 2009), to perform a power analysis using a 90% power to detect a mean paired differences of 6 degrees with an estimated standard deviation (SD) of 4 degrees (effect size of 1.13) and a significance level (alpha) of 0,05 using a two-sided paired student t-test. The sample required was 11, however a sample of 20 was used to account for the possibility of a smaller effect size of participants who were enrolled (as recommended by Esterhuizen, 2019).

All participants were allocated to one group, with multiple measures. Thus, they were their own control, i.e. each participant's posture was assessed with and without the cushion, while carrying out a reading task on a computer screen, similar to that of Douglas and Gallagher (2017). In order to randomise the collection of the data, participants were randomly allocated to either group one or two through the use of a random allocation chart, generated through Microsoft Excel. Those allocated to group A had their data collected with the use of the RidgeBack™ thoracic cushion first and then without the cushion. Those in group B had their data collected without the use of the cushion and then used the cushion in their second sitting. This was done to minimise bias.

3.4.2 Sample Characteristics and Recruitment

Advertisements (Appendix E) were placed on notice boards at the DUT Steve Biko campus as well as the Chiropractic Day Clinic at the Durban University of Technology after permission was obtained from the Research Director of the Institution (Appendix B). Recruitment was also done by word of mouth. The participants contacted the researcher telephonically for more information. On contacting the researcher, the participants were asked the questions outlined in Table 3.1.

Table 3.1: Telephonic screening questions

Questions Asked Of Participants	Expected Answers
May I ask you a few questions in order to determine your eligibility into this study?	Yes
How old are you?	Between ages of 18-45
Do you currently have neck or back pain?	No
Have you undergone surgery to your spine?	No
Have you been diagnosed with scoliosis, osteoporosis, osteoarthritis or ankylosing spondylitis?	No
Are you in good health?	Yes

If the participants did not meet the telephonic preliminary selection, they were thanked for their interest and not enrolled in the study. Those who met the criteria were requested to attend an appointment at the DUT CDC where they were assessed further to confirm their inclusion in the study.

3.4.2.1 Inclusion Criteria

The following points summarise the inclusion criteria for participants:

- Participants were between the ages of 18 and 45. The age was limited as Miller (2004) stated that before the age of 45 years, the incidence of degeneration of the spine is minimal, thus reducing the likelihood that arthritic changes could have influenced the results.
- Participants were asymptomatic for spinal, hip, shoulder, elbow and knee pain because pain could influence seated posture (Brink *et al.* 2015).
- Participants were required to give informed consent by completing and signing an informed consent form (Appendix F) after receiving the letter of information (Appendix G).

3.4.2.2 Exclusion Criteria

The following points summarise the exclusion criteria for participants:

- Participants who had a history of surgery because of the risk of spinal curvature flattening after spinal cord decompression surgery and spinal fusions effecting a change in posture (Zimmerman *et al.* 2010).
- A history of any major injuries or diseases which caused structural deformities to their spine, paralysis or atrophy (Ranawat *et al.* 2015).
- Participants who had been diagnosed with arthritides or osteoporosis (Katzman *et al.* 2011).
- Participants who had a hyperkyphotic thoracic curve, which was noted by the researcher during the postural assessment (Katzman *et al.* 2011).
- Participants who were defined as underweight or obese according to the Body Mass Index (BMI) rating, as it was would have been difficult to find anatomical landmarks (as recommended by Schaudinn *et al.* 2015).

3.5 INDEPENDENT AND DEPENDANT VARIABLES

As defined by Mouton (2002), an independent variable can be manipulated by the researcher, such as a treatment intervention, and can result in a change in the dependent variable. Also known as the outcome variable, the dependent variable changes in order to see the effect of the independent variable (Mouton 2002).

- Independent variable – RidgeBack™ thoracic spine postural cushion.
- Dependant variables – Posture Number™, forward head posture, head translation, head force, hip translation and comfort rating.

3.6 MEASUREMENT TOOL

3.6.1 The Posture Pro Analysis System

This was a digital system that provided the ability to quantitatively document a patient’s posture. Senthil *et al.* (2018) stated that the Posture Pro software was found to be a reputable and reliable form of posture assessment which benefitted many patients who sought help from health care professionals.

A plumb line was used as an aid during the setup of each participant at the workstation. It consisted of a rope with a bob attached to it and was hung from a stable structure. It was used to ensure the markers just posterior to the hip joint and the two markers below it were aligned at zero degrees. This was done to ensure reliability of the measurements taken in the Posture Pro software.

In order to accurately place the reflective markers used to mark the landmarks for photographic analysis, the participant was asked to wear tight fitting clothing with no sleeves. Participants were only allowed to wear plain black, navy or white clothes to ensure the red markers were easily recognised by the Posture Pro software. This was to prevent analysis of incorrect points due to other colours present on the clothing. An observational checklist (Appendix H) assisted the researcher to set up each participant at the workstation utilised in the study. Bohr (2000) reported that the checklist enabled validity and reliability of the office workstation due to all necessary factors involving seated posture being included within the checklist regarding a workstation setup.

A camera on a tripod was set up one meter away from the office chair. White masking tape on the floor marked where the office chair sat and where the camera tripod was placed. The camera was set up on a portrait orientation at a height of 82cm (floor to bottom edge of camera) and a level was used to ensure the camera was straight.

The photographs were transferred onto a password protected memory device and then loaded and saved directly onto the Posture Pro software on the DUT departmental laptop. After each photo was loaded onto Posture Pro software, the software system automatically generated the necessary posture measurements which were recorded onto an Excel spreadsheet for statistical analysis.

The objective measures as detailed below were obtained from the analysis of the participants' photos in the Posture Pro software.

3.6.1.1 Objective Measures

- **Posture Number™**

This was automatically generated by the Posture Pro software. It was created by using the five anatomical markers on the external auditory meatus, centre of the shoulder, just posterior to the hip joint and two extra markers were placed, specifically for seated posture, on the plumb line at zero degrees with one another to calculate a number. Table 3.2 below shows the categories and their descriptions into which these numbers fell.

Table 3.2: Posture Number™ Categories (Ventura Designs 2012)

Category Number	Amount Of Stress/Damage
0-5	Little to no structural stress detected, monitor and re-evaluate in 6 months
6-10	Beginning of structural stress and increased tension on the musculoskeletal system, monitor closely and re-evaluate in 90 days.
11-15	Structural stress is evident.
16-20	Stress and tension are causing symptoms that need to be addressed.
20-30	Structural damage is occurring and needs to be prevented.
30+	Structural damage has occurred, life-long problems may already exist.

- **Forward Head Posture**

This number represented the amount of forward head travel, in degrees, by measuring the angle between the external auditory meatus and the centre of shoulder anatomical marker.

- **Head Translation**

This was the movement of the head forward or backward from the shoulder anatomical marker, measured in millimetres and was automatically generated by the Posture Pro software.

- **Head Force**

This was the force applied by the head due to its forward translation, measured in kilograms. The greater the forward translation of the head was, the greater the weight. This was generated automatically by the Posture Pro software.

- **Hip Translation**

The Posture Pro software measured the amount of movement of the hip forward or backward from what was expected to be normal posture, measured in degrees.

Figure 3.1 illustrates the objective measures generated by the Posture Pro software utilised in this study.

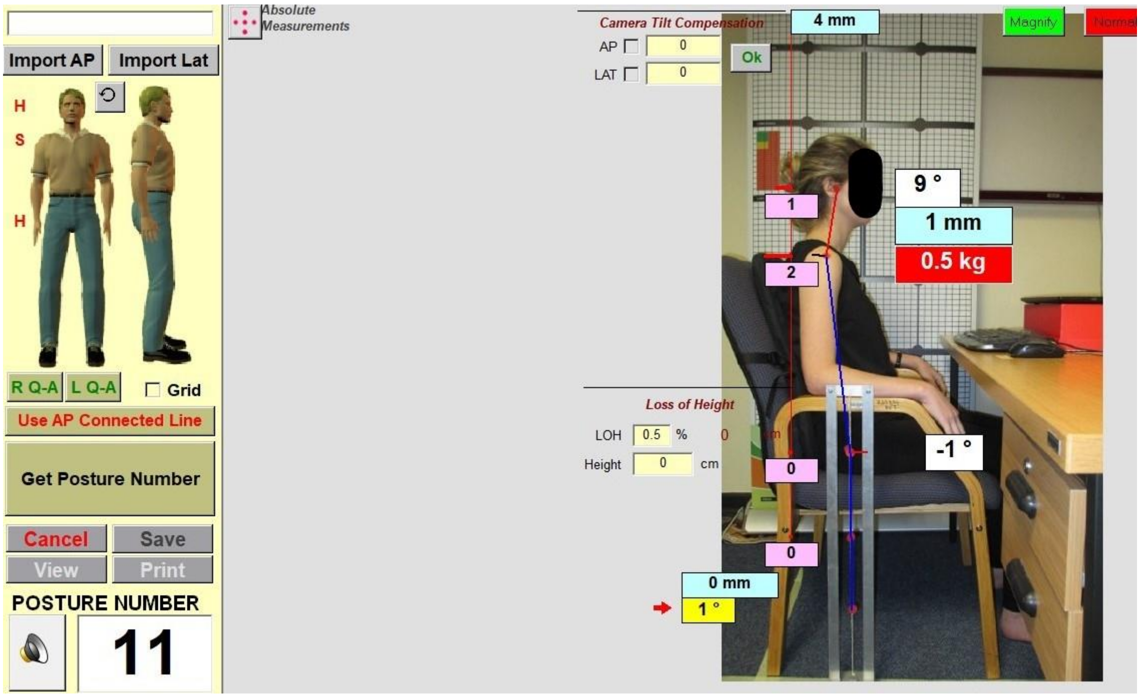


Figure 3.1: Illustration of the measurements in the Posture Pro software

3.6.2 Subjective Measure

3.6.2.1 Comfort Scale

A Likert-type scale, used by Gibaut *et al.* (2013), was used to measure the participants' comfort with and without the thoracic spine postural cushion. The scale consisted of the following categories:

1 - not comfortable at all;

2 - not very comfortable;

3 - more or less comfortable;

4 - very comfortable; and

5 - totally comfortable

In this study, participants were given the scale (Appendix I) where they marked an “X” in the box which appropriately resembled their comfort rating after they had completed the reading task, both with and without the cushion.

3.7 INTERVENTION

The thoracic cushion used in this study was the RidgeBack™. It was a 315mm x 525mm rectangular cushion made up of a central ridge of high density chipfoam surrounded by memory foam for comfort. Cotton Twill fabric covered the cushion shown in Figure 3.2 (Randall 2018).

Figure 3.2: A photograph of the RidgeBack™ cushion

An office chair from the Chiropractic department, displayed in Figure 3.3, was used for the study. The chair was stabilised on four legs, had a seat height of 45cm, backrest height of 56cm, arm rests, and a slight inclination of the backrest, which met the requirements of a standard office chair (Kroemer and Kroemer 2001). The RidgeBack™ cushion was strapped to the backrest of the chair with the bottom border of the cushion resting on the seat of the chair.

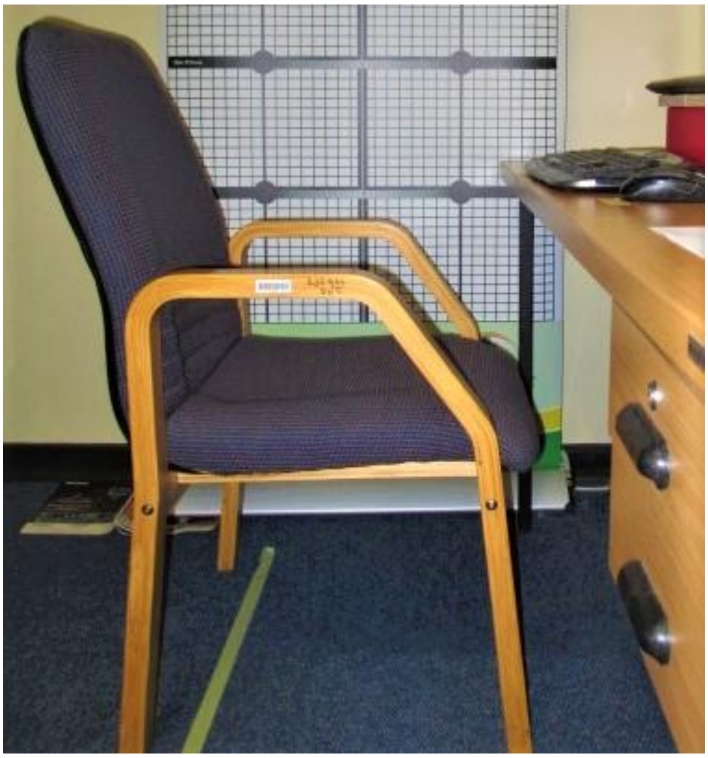


Figure 3.3: A photograph showing the office chair used in the study.

A laptop computer screen was set up on the desk in front of the chair, with a distance of 45-60cm from the edge of the desk and at a height of 90-115cm measured from the floor, just lower than the participant's eye level (as recommended by Grandjean 2002).

3.8 DATA COLLECTION AND RESEARCH PROCEDURE

Once the participant met the criteria via telephonic screening, an appointment was made at the DUT CDC.

At the appointment, the researcher conducted a postural assessment (Appendix J) and recorded height, weight and BMI to ensure eligibility to the study.

Once the participant was included in the study, the researcher verbally explained the procedure and the participant was given a letter information (Appendix G) and asked to sign an informed consent form (Appendix F). Time was given for the participant to ask any questions.

The researcher had one permanent ergonomically set up workstation and camera at the DUT CDC where each participant was assessed, with a checklist to standardise the study. A foot rest was provided to participants who could not reach the floor comfortably.

The participants were asked to sit at the workstation while the researcher completed the observational checklist (Appendix H) which was completed before the commencement of each task. The researcher placed round, red anatomical markers on the participant (external auditory meatus, centre of the shoulder, posterior to the hip joint). The markers stayed on the participant until the end of the second reading task. Two extra markers were placed onto the plumb line for Posture Pro purposes. These markers were aligned with the hip at zero degrees.

Each participant had their own file with their names on where information was collected and stored during the data collection process. The participant was positioned in the seat, looking at the computer screen with their forearms rested on the arm rests of the office chair, as shown in Figure 3.4 below.

The procedure in this study, whereby the participants carried out a reading task at a computer screen, was similar to that of Douglas and Gallagher (2017). Before the reading task commenced, the first photograph was taken. The participants then carried out the reading task for two minutes. The second photograph was taken after one minute into the reading task and the next at two minutes and the order of whether the measures were taken with or without the RidgeBack™ postural cushion first was determined by the random allocation chart.

Figure 3.4: A photograph showing workstation setup while a participant used the postural cushion.

A stopwatch was used to time the photographic increments which ensured that the photographs were taken at the correct points (commencement of the reading task, one minute and two minutes).

On completion of the initial reading task, the participant was given the comfort indicator with their name on it. They rated their comfort using a Likert Scale (Appendix I). Following that, they stood up from the office chair and walked around the room for one minute while the researcher set up the second part of the task. O'Sullivan *et al.* (2010) tested different sitting postures immediately after one another. Thus, the one-minute break in this study was sufficient to allow the researcher to re-adjust the reading task.

The second readings were obtained in the same manner as described above, except with or without the cushion as determined by the random allocation chart. Once the participant had completed both tasks and rated their comfort, they were thanked for their time and were allowed to leave.

3.9 DATA STORAGE AND ANALYSIS

Photographs were stored on a password protected hard drive until the research was completed. Coding systems were used instead of names, and all data was transferred onto an Excel spreadsheet.

Descriptive data of the participants was reported as means and standard deviations in the case of quantitative normally distributed data, or as count percentage for categorical variables where appropriate. Interferential statistics like paired t-tests were used to assess differences between means of outcome variables while using the cushion compared to not using the cushion. A p value <0.05 indicated statistical significance (Matthews 2020).

3.10 ETHICAL CONSIDERATIONS

A signed contract (Appendix D) allowed the researcher permission from the RidgeBack™ developer to use the postural cushion in the study and publish the outcomes of using the cushion, whether the outcomes were positive or negative.

Informed consent (Appendix G) was obtained from each participant, which tied in with the principle of autonomy. It was explained to participants that they were free to leave the study if they wished to do so, without prejudice.

The rights and welfare of the participants were protected by blacking out their eyes in the photographs which were stored safely on a password protected flash drive which only the researcher had access to. No harm was done to the participants ensuring non-maleficence.

Participants were not coerced into participating in the study. Every participant who met the inclusion criteria was invited to participate in the study and there was no discrimination in terms of race, gender or age (under the age of 45), thus, the principle of justice was maintained.

Participation was voluntary and did not involve financial benefits. However, this study benefitted the participants with regards to knowledge of posture correction and ergonomic importance, adhering to the beneficence principal.

The postural assessment, Posture Pro software and the RidgeBack™ were non-invasive and had no risk to the participants.

The participants were referred to under codes and their names were not used on the data sheets. The research data will be kept in a safe place at the DUT CDC for a period of five years. After such a period, the research data will be shredded. The rights and the welfare of participants is protected.

Permission to use the DUT CDC for research purposes, distribution of advertisements on DUT campuses and granting permission to access staff and students of DUT was obtained through the gatekeeper's committee from the Research Director (Appendix C).

Chapter Four

Results

4.1 INTRODUCTION

This chapter will present the results of the study in the form of diagrams, cross-tables and graphs. The results will initially discuss the participant characteristics followed by the results presented per objective.

4.2 SAMPLE SIZE

The sample size consisted of 20 participants who consented to participate in the study. They were allocated to a group, where they were their own controls. Figure 4.1 shows the flow of the participants through the recruitment process.

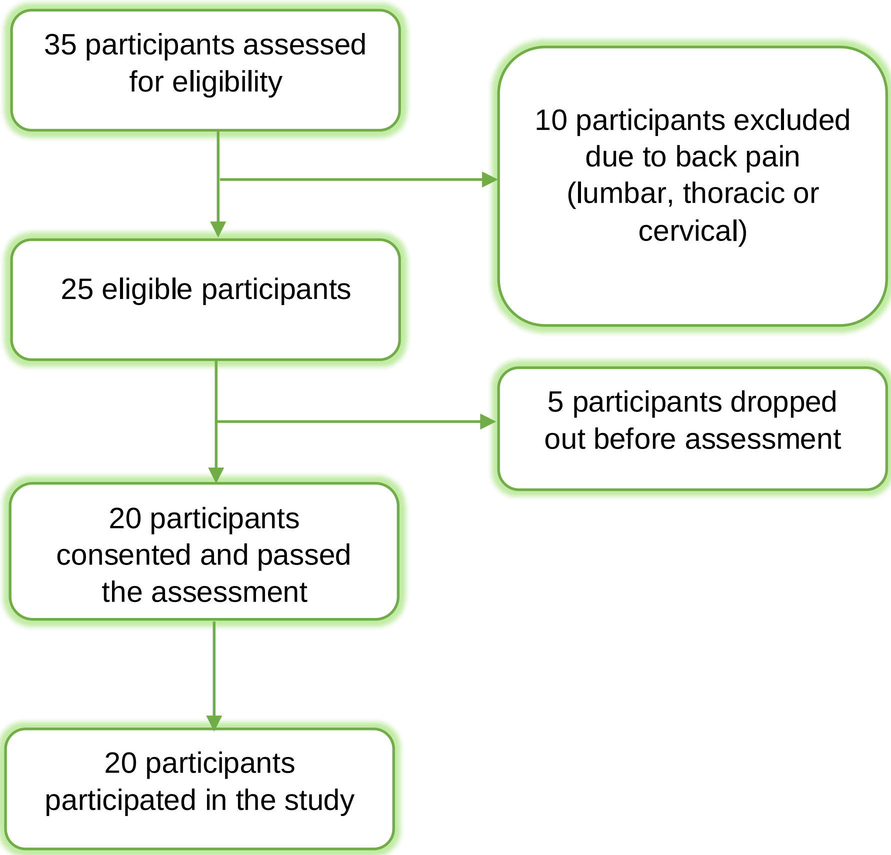


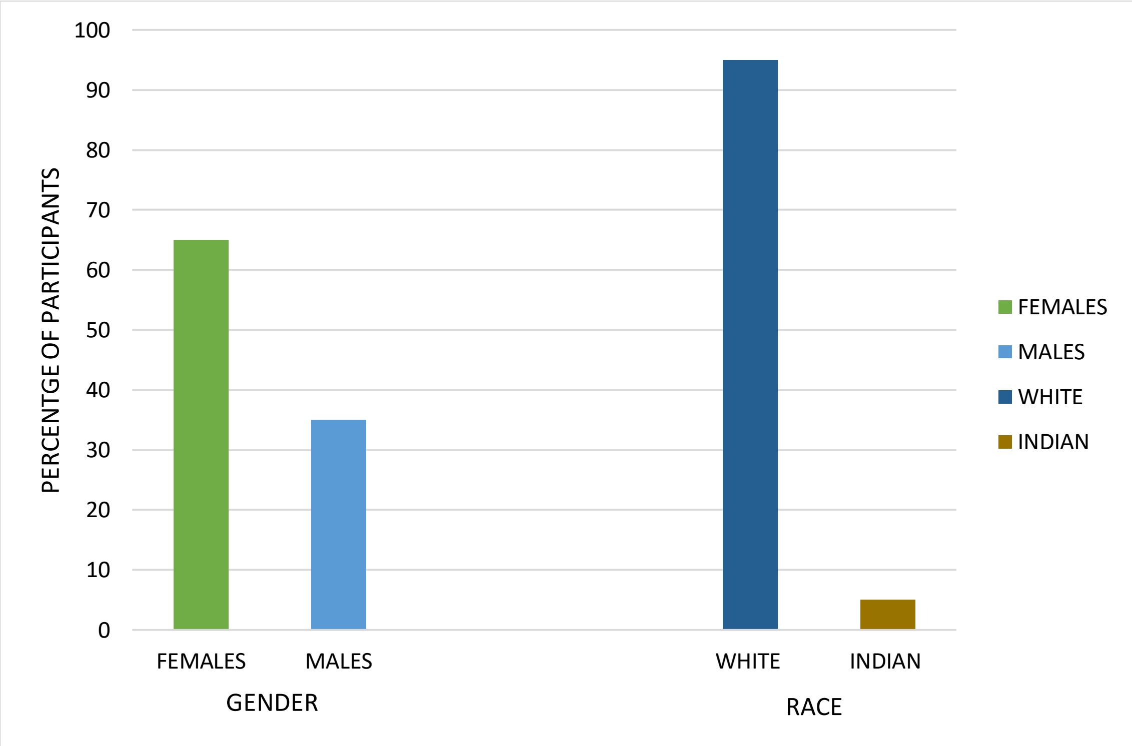
Figure 4.1: Flow diagram showing participants through recruitment process

4.3. PARTICIPANT CHARACTERISTICS

4.3.1 Age, gender and race

The mean age of the participants was 27.10 (±3.74), with a range of 19 to 36. Table 4.2 shows the gender and race of the study participants. The majority of the participants were female and there were only participants from the White and Indian population groups.

Figure 4.2: Demographic characteristics of the participants



4.3.2 Height, Weight and Body Mass Index (BMI)

Table 4.1 shows the height, weight, and mean BMI of the participants. The participants' BMI reading when categorised was "normal".

Table 4.1: Height, weight, and Body Mass Index of the participants

BMI Characteristic	N	Mean	Std. Deviation	Minimum	Maximum
Height (m)	20	1,68	0,08	1,52	1,79
Weight (kg)	20	68,88	10,48	49	83
Mean BMI	20	23,05	2,67	20	28

4.4 RESULTS REPORTED PER OBJECTIVE

4.4.1 Objective 1: To determine seated posture without the RidgeBack™ cushion initially then at one and two minutes into a reading task in terms of the objective outcomes.

Table 4.2 shows that over the duration of the study there were no significant changes observed in the objective measures, without the RidgeBack™ postural cushion. Assessed using repeated measures analysis of variance (ANOVA).

Table 4.2: Mean objective measures found over time without the RidgeBack™

		Baseline/0min	I min	2 min	
	N	M (±SD)	M (±SD)	M (±SD)	*p*-value
Forward Head Posture (FHP)	20	20,85 (6,50)	21,15 (6,78)	21,30 (6,51)	0,61
Head Translation	20	62,25 (20,77)	63,25 (21,01)	63,35 (20,43)	0,64
Head Force	20	33,41 (11,15)	33,86 (11,26)	33,99 (10,97)	0,74
Posture Number™	20	23,15 (7,17)	23,45 (7,16)	23,70 (6,33)	0,56
Hip Translation	20	-1,15 (0,49)	-1,20 (0,52)	-1,10 (0,31)	0,60

4.4.2 Objective 2: To determine seated posture with the RidgeBack™ cushion initially then at one and two minutes into a reading task in terms of the objective's outcomes.

Using repeated measures ANOVA, there were no significant changes found for the objective outcomes, over the duration of the study, when using the RidgeBack™ postural cushion, as seen in Table 4.3.

Table 4.3: Mean objective measures found over time when using the RidgeBack™

		Baseline/0min	**I min**	**2 min**	
	N	**M (±SD)**	**M (±SD)**	**M (±SD)**	***p*-value**
FHP	20	16,30 (5,93)	16,30 (5,67)	16,30 (5,56)	1,00
Head Translation	20	48,65 (19,58)	48,35 (18,21)	48,10 (17,56)	0,94
Head Force	20	26,19 (10,49)	25,85 (9,81)	25,78 (9,42)	0,78
Posture Number™	20	18,45 (6,13)	18,25 (5,62)	18,30 (5,70)	0,75
Hip Translation	20	-1,05 (0,39)	-0,90 (0,55)	-1,05 (0,39)	0,39

4.4.3 Objective 3: To compare the objective measurements (initial, one and two minute) obtained with and without the cushion.

4.4.3.1 Mean Forward Head Posture

Figure 4.3 shows that at baseline there were significant differences in mean forward head posture (FHP) ($p < 0.001$) with the use of the cushion decreasing FHP compared to without the cushion. Significant differences were observed at one ($p < 0.001$) and two minutes ($p < 0.001$), where the results showed that without the cushion there was an increase, compared to with the cushion, which maintained the degree of FHP. Paired student t-tests were utilised in the analysis.

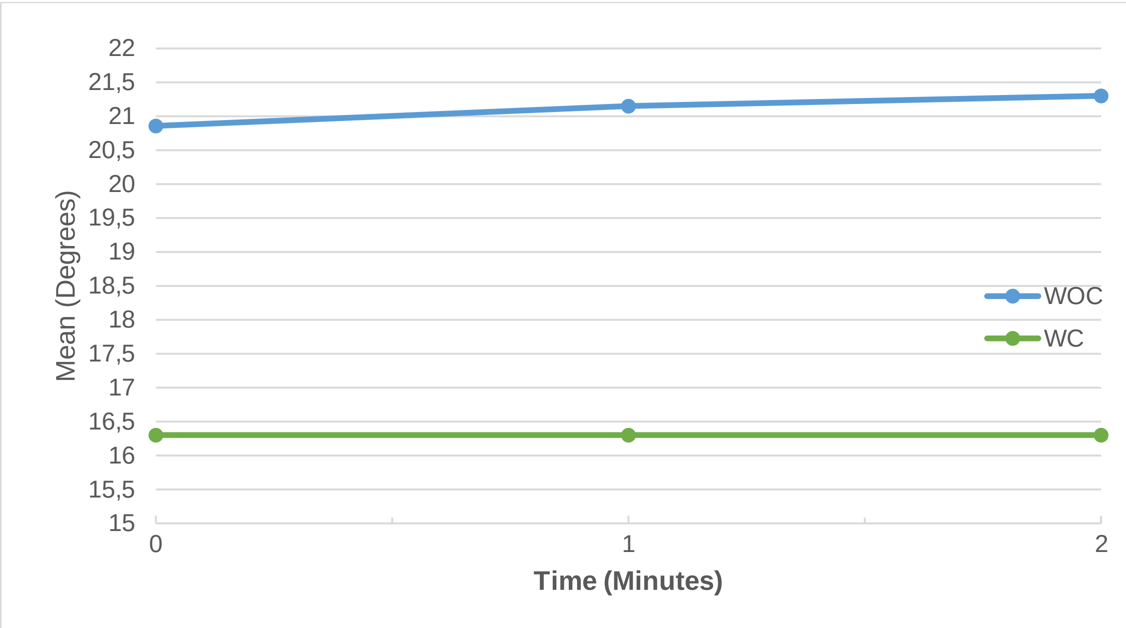


Figure 4.3: Comparison of mean forward head posture with and without RidgeBack™ over time

4.4.3.2 Mean Head Translation

Comparisons between the results with and without the RidgeBack™, using paired student t-tests, showed that at baseline (p < 0.001) mean head translation with the cushion was significantly lower than without the cushion. Similar differences were found at one minute (p < 0.001) and two minutes (p < 0.001), with mean head translation decreasing with the use of the cushion in contrast to with the cushion where mean head translation increased, as seen in Figure 4.4.

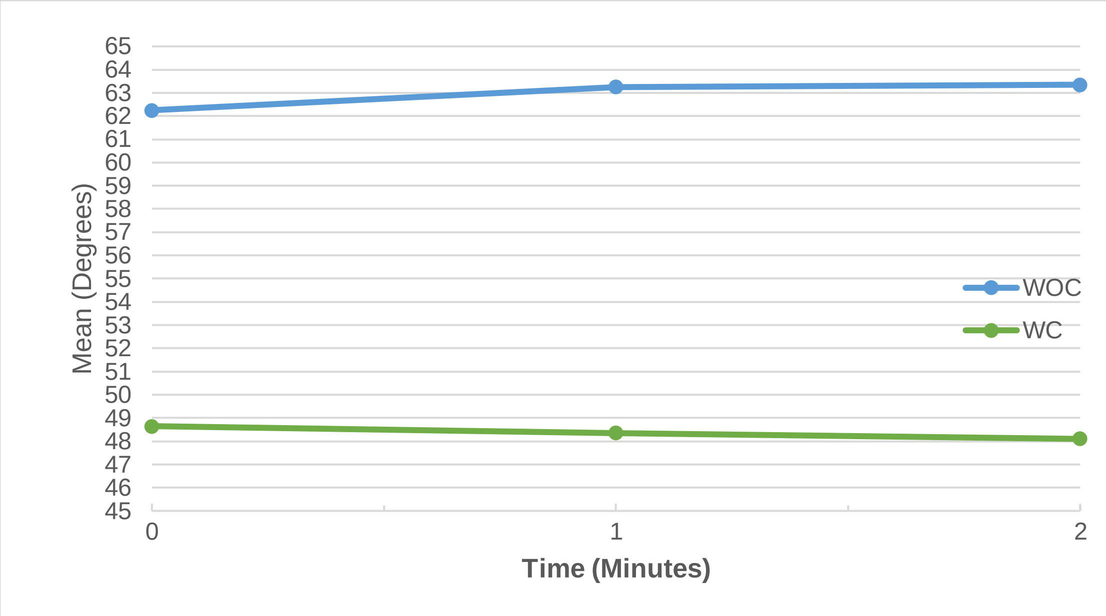


Figure 4.4: Comparison of mean head translation with and without the RidgeBack™ over time

4.4.3.3 Mean Head Force

Mean head force was significantly lower at baseline (*p* < 0.001) with the cushion when compared to without the cushion. At one (*p* < 0.001) and two minutes (*p* < 0.001) there were significant differences with the results, with the cushion increasing compared to without the cushion for mean head force, using paired student t-tests, as seen in Figure 4.5.

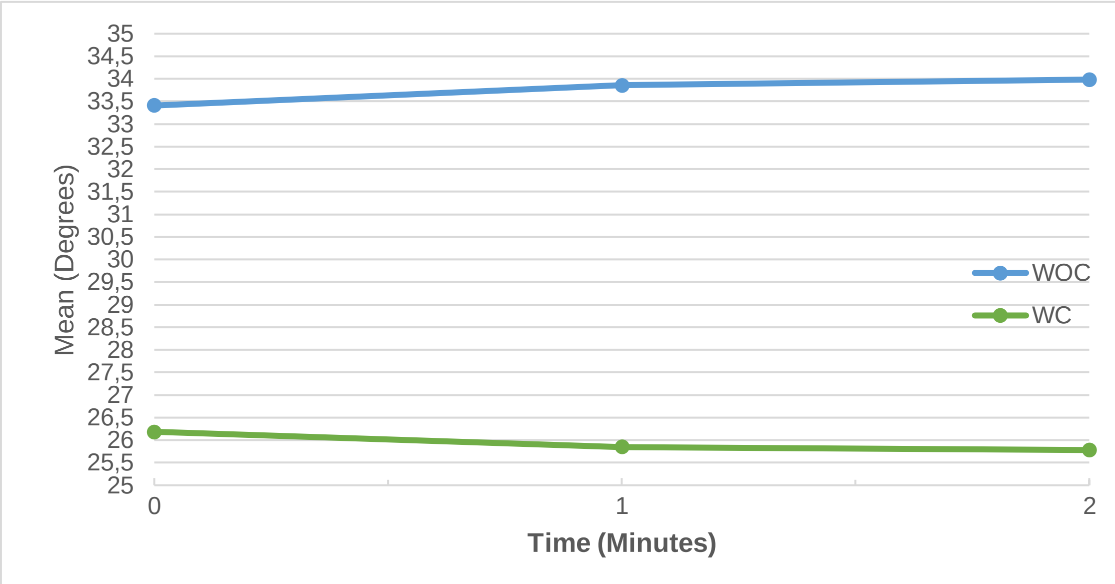


Figure 4.5: Comparison of mean head force with and without the RidgeBack™ over time

4.4.3.4 Mean Hip Translation

Figure 4.6 shows no significance between the two groups for hip translation at baseline (p = 0.428), at one minute there was a borderline significant result with mean hip translation increasing with the cushion, and decreasing without the cushion (p = 0.055). At two minutes, mean hip translation with and without cushion showed no significant difference (p = 0.577). Tests were performed using paired student t-tests.

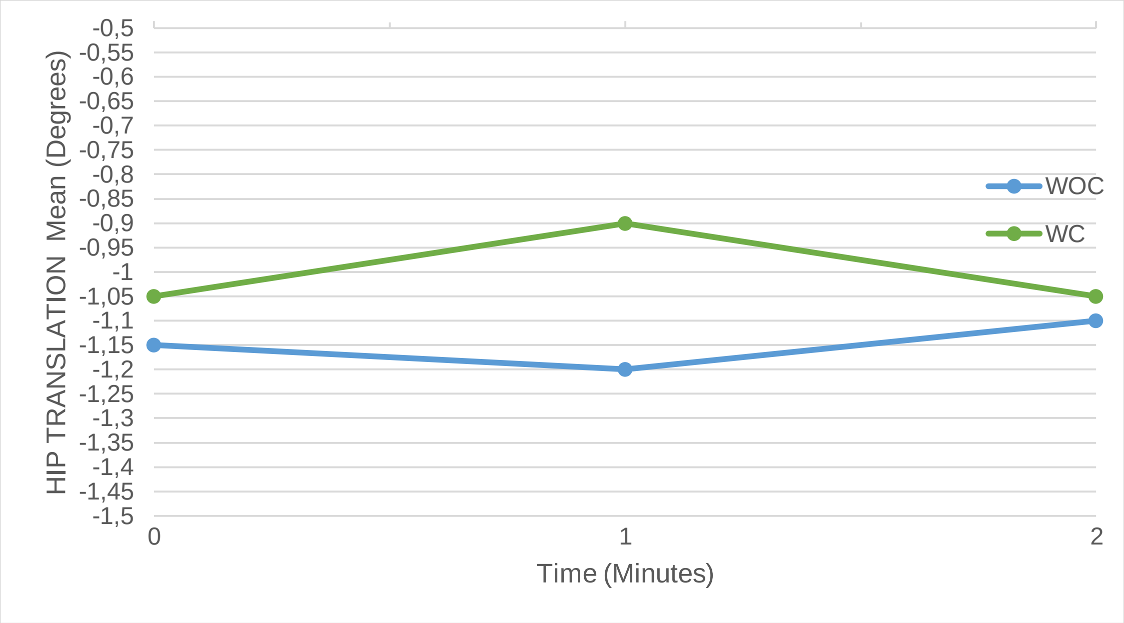


Figure 4.6: Comparison of mean hip translation with and without the RidgeBack™ over time

4.4.3.5 Mean Posture Number™

Figure 4.7 shows that at baseline mean posture number with and without the cushion were significantly different ($p < 0.001$). With the mean posture number™ being higher when the cushion was not used. Significant differences were observed at one ($p < 0.001$) and two minutes ($p < 0.001$), with the mean Posture Number ™ increasing when the cushion was not used. Tests were conducted using paired student t-tests.

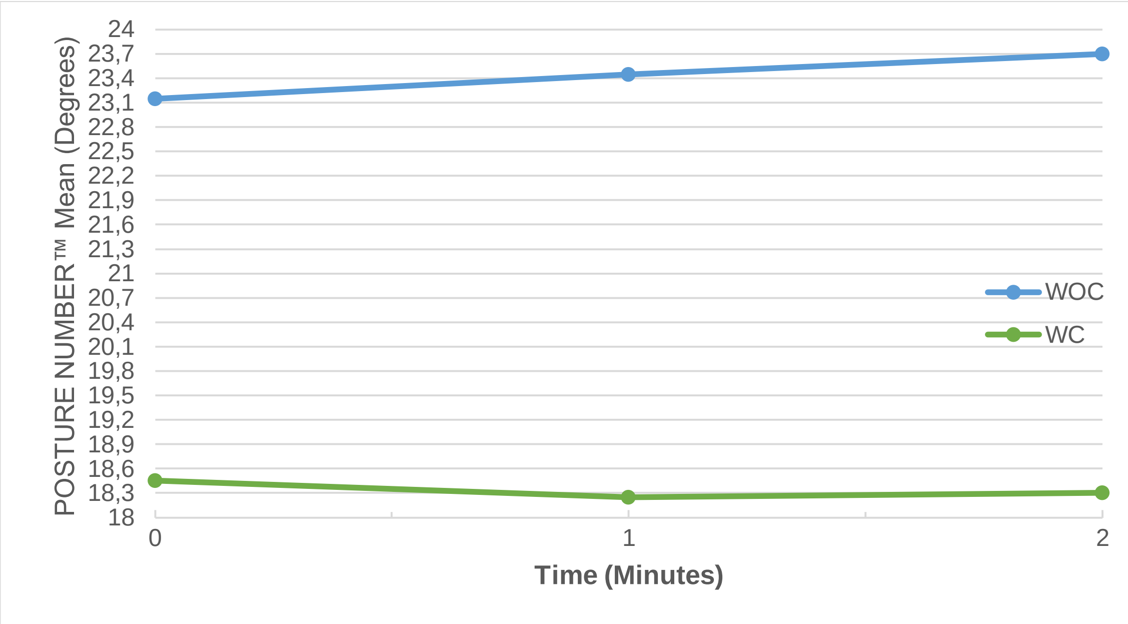


Figure 4.7: Comparison of mean Posture Number™ with and without the RidgeBack™ over time

4.4.4 Objective 4: To determine the subjective comfort rating of participants while performing the reading task with and without the RidgeBack™ cushion.

Table 4.4 shows that more participants reported a higher comfort rating when using the cushion, but this finding was not significant, when using Fischer's Exact test (*p* = 0.071).

Table 4.4: Participants' comfort ratings WOC and WC

Comfort Category	WOC n (%)	WC n (%)
Not comfortable at all	0 (0)	0 (0)
Not very comfortable	3 (15)	4 (20)
More or less comfortable	13 (65)	6 (30)
Very comfortable	4 (20)	6 (30)
Totally comfortable	0 (0)	4 (20)
Total	20 (100)	20 (100)

Chapter Five

Discussion

5.1 INTRODUCTION

This chapter will discuss the results of this study in the context of the available literature.

5.2 DISCUSSION OF PARTICIPANT DATA

5.2.1 Age, Gender and Race

Age is an important factor when measuring posture because individuals over the age of 45 years are more prone to degenerative changes in the spine, such as osteoarthritis, causing pain and a decrease or increase in normal spinal curvatures, altering posture (Miller 2004; Neogi 2013). The aging population may be associated with decreased muscle mass and muscle tone, and decreasing strength and potential ability to sit at a desk for prolonged periods without muscle fatigue (Billot *et al.* 2010). All the participants in this study were between the ages of 19 and 36, to mitigate these effects. This age range also better represents the employed population, as aged workers are considered a minority (Principi *et al.* 2015).

The study population included both male (35%) and female (65%) participants, but there is little evidence in adults to suggest an association between gender and posture in the literature. Coelho *et al.* (2014), in research on school children reported that there was no significant difference between posture and gender. Although when discussing back pain affected by sitting ergonomics, it has been found that musculoskeletal pain was more prevalent in females (Lee *et al.* 2018).

Similarly, there is a paucity of literature related to differences in posture in the different race groups. This study had a majority of white participants with very little representation from the other race groups in South Africa. Thus, these findings may be limited to only people from the white race group.

5.2.2 Body Mass Index

Location of anatomical landmarks in obese individuals have shown to be less accurate when compared to individuals with a normal BMI rating (Schaudinn *et al.* 2015). Thus, this study excluded participants who were defined as underweight or obese to increase the reliability of the results.

5.3 DISCUSSION OF RESULTS

Prolonged poor sitting postures are related to musculoskeletal pain and disability. Research shows that such postures are associated with pain, particularly in the back (Stenlund *et al.* 2014). Incorrect sitting for long periods of time leads to muscle fatigue and may cause muscle hypertonicity. This can manifest as long-term postural alterations such as FHP and rounded shoulders, which increases the thoracic spinal curve, resulting in hyperkyphosis and thoracic spine discomfort and/or pain (Singla *et al.* 2017).

This study investigated a novel thoracic spine cushion which was purported to relieve cervical, thoracic and lumbar spine pain by correcting an individual's seated posture while driving or sitting at a desk (Randall 2019). There is a lack of literature with which to compare the results of this study as the only other study investigating thoracic spine supports looks at seat pressure and comfort. The cushion showed significant reduction in all outcomes except hip translation when compared to seated posture without the cushion. The lower scores for measures of FHP, forward head translation and head force indicated that there was closer vertical alignment of the external auditory meatus and the acromion process, positively impacting seated posture (Magee 2013). FHP is common, and often associated with pain. It leads to muscular tension of the upper back and neck muscles resulting in tension type headaches which may be debilitating for an individual (Fortner *et al.* 2018), highlighting the importance of posture devices and exercise to prevent FHP.

This study showed that the Posture Number™ simultaneously and significantly decreased when there was a decrease in FHP, forward head translation and head force, leading to an overall favourable change in posture (Senthil *et al.* 2018; Ventura Designs 2012). When the cushion was used there was little change in the posture number from baseline, in contrast to without the cushion where the posture number increased – indicating a negative effect. The Posture Number™ is a unique measure calculated by the Posture Pro software using the values for FHP, head translation, head force, hip translation. Thus, comparison with other literature, with regard to this measure, is limited.

The results also showed that there were no statistically significant changes in the outcome measures from baseline to two minutes when the cushion was used. This indicates that the RidgeBack™ was able to effectively maintain the posture over the two-minute period.

The exploratory nature of this study limited the reading time to 2 minutes to see if the cushion did result in changes. O'Sullivan *et al.* (2012) assessed seated posture over one minute while participants sat on a standard chair and Qian *et al.* (2018) only used ten seconds to assess three different seated postures. Thus, this study used a longer time frame than that reported in the literature. However, future studies should include a longer duration, to establish the long-term effect of the cushion on posture. Thoracic spine pain, is common and debilitating, and often experienced by workers related to prolong sitting (Briggs *et al.* 2009). Poor sitting postures negatively impact the health of an individual, and poses a risk of financial strain to the patient due to medical costs, and to the employer due to absenteeism and reduced work productivity (Wieser *et al.* 2011), highlighting the need to ensure adequate support while sitting.

One outcome, hip translation showed no significant change, with or without the cushion, over the duration of the study. The procedure followed in this study required participants to sit with their buttocks to the back of the office chair, with their feet flat on the floor or foot rest, hip width apart, while their arms relaxed on the arm rests of the office chair with the elbows aligned to the shoulders, following the procedure as outlined by Kwon *et al.* (2018). Hip translation was measured by assessing markers placed on the acromion process, hip and first plumb-line marker which is normally placed on the knee when assessing standing posture. It is possible that the duration of the study was not sufficient to allow 'postural fatigue' and a change in hip translation that would occur as a result. Prolonged slouching is a common deviation in normal seated posture causing musculoskeletal pain and discomfort (Wong *et al.* 2019).

In terms of comfort rating, this study used a similar scale used by Gibaut *et al.* (2013). Although there was no statistical significance of subjective comfort rating (p = 0.071) when comparing sitting with and without the RidgeBack™, 20% of participants rated their comfort in the two highest categories of comfort (4 and 5) when not using the cushion, compared to 50% when using the cushion. Beach *et al.* (2003) found when testing, subjective seated comfort that discomfort increased as time progressed. The short duration of this intervention may not have been sufficient to test comfort, but as this is a novel cushion, it was an important element that needs to be considered.

Chapter Six

Conclusion

6.1 INTRODUCTION

This chapter will conclude the study, provide the limitations and recommendations for future research.

6.2 CONCLUSION

The aim of this study was to determine the effect of a thoracic spine postural cushion on seated posture in asymptomatic participants, during a reading task initially, then after one and two minute intervals, in terms of subjective (comfort rating) and objective outcomes (angle of forward head posture, head translation, head force, hip translation and Posture Number™), as recorded by the Posture Pro software. The results of this study provided evidence to reject the null hypothesis that stated that there would be no statistically significant difference between seated posture without the RidgeBack™ cushion and seated posture with the RidgeBack™ cushion.

The study showed a significant positive effect of the RidgeBack™ cushion in decreasing forward head posture, head force, head translation and Posture Number™ in seated posture. Hip translation and patient rating of comfort did not produce evidence to reject the null hypothesis, yet there was a trend that more participants found the RidgeBack™ cushion comfortable when sitting in the office chair than when the cushion was not used.

The results of this study support the use of the RidgeBack™ cushion to improve seated posture, however the results require further testing in a more diverse population group and over a longer duration. The participants in this study were pain free, thus its use in a population with pain requires further investigation.

6.3 LIMITATIONS

The following limitations were highlighted during the course of this study:

1. The study only included asymptomatic participants therefore it was noted that the results of the study are not applicable to symptomatic individuals.
2. One standard office chair was used and it was recognised that a different office chair may have changed the outcome of the study.
3. One photogrammetry measurement tool was used to assess posture. Multiple tools may further validate the reliability of the study results.
4. The reading task was done over a period of two minutes during one consultation, therefore a longer reading task over multiple consultations may change the results of the study.
5. The comfort rating was a subjective measure which may change with each participant.

6.4 RECOMMENDATIONS

1. Future research should include a more diverse population group to ensure that the findings are reproducible in different populations.
2. Future studies should use symptomatic participants which may generate different and more clinically sound results.
3. Researchers should consider including multiple types of office chairs during the testing process to conclude whether the outcomes would remain favourable in further research of this study.
4. Other measuring tools are recommended to validate the reliability of the posture measures found in this study.
5. Future research should be carried out over a longer period of time to investigate if there will be a change in seated posture in periods longer than two minutes while using the thoracic spine cushion.

6. The distribution of the thoracic spine cushion to participants over a longer period of time is advised to investigate the claims that the cushion relieves cervical, thoracic and lumbar spine pain.

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APPENDICES

APPENDIX A: IREC APPROVAL

DUT
DURBAN
UNIVERSITY OF
TECHNOLOGY

Institutional Research Ethics Committee
Research and Postgraduate Support Directorate
2nd Floor, Berwyn Court
Gate 1, Steve Biko Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

25 July 2019

Miss K-L Young
13B Reservoir Road
Winston Park
3610

Dear Miss Young

The effect of a thoracic spine postural cushion on seated spinal posture in asymptomatic participants in the eThekwini municipality.
Ethical Clearance number: IREC 087/19

The Institutional Research Ethics Committee acknowledges receipt of your gatekeeper permission letters.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC Standard Operating Procedures (SOP's).

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely

Professor J K Adam
Chairperson: IREC

DUT
2019 -07- 25

APPENDIX B: PERMISSION TO CONDUCT RESEARCH AT DUT

DUT DURBAN UNIVERSITY OF TECHNOLOGY | DIRECTORATE FOR RESEARCH AND POSTGRADUATE SUPPORT

Directorate for Research and Postgraduate Support
Durban University of Technology
Tromso Annexe, Steve Biko Campus
P.O. Box 1334, Durban 4000
Tel.: 031-3732576/7
Fax: 031-3732946

22nd July 2019

Ms Kerry-Lee Young
c/o Department of Chiropractic and Somatology
Faculty of Health Sciences
Durban University of Technology

Dear Ms Young

PERMISSION TO CONDUCT RESEARCH AT THE DUT

Your email correspondence in respect of the above refers. I am pleased to inform you that the Institutional Research and Innovation Committee (IRIC) has granted full permission for you to conduct your research "The effect of a thoracic spine postural cushion on seated spinal posture in asymptomatic participants in the eThekwini municipality" at the Durban University of Technology.

The DUT may impose any other condition it deems appropriate in the circumstances having regard to nature and extent of access to and use of information requested.

We would be grateful if a summary of your key research findings can be submitted to the IRIC on completion of your studies.

Kindest regards
Yours sincerely

PROF KEVIN DUFFY
ACTING DIRECTOR: RESEARCH AND POSTGRADUATE SUPPORT DIRECORATE

APPENDIX C: PERMISSION TO CONDUCT RESEARCH AT THE DUT CDC

MEMORANDUM

To : Prof Adam
Chair: IREC

From : Dr Laura O'Connor
Head of Department: Chiropractic

Dr Desiree Varatharajullu
Clinic Director: Chiropractic Day Clinic: Chiropractic

Date : 24.07.2019

Re : Request for permission to use the Chiropractic Day Clinic for research purposes

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Permission is hereby granted to:

Ms Kerry-Lee Young (Student Number: 21210020)

Research title: "The effect of a thoracic spine postural cushion on seated spinal posture in asymptomatic participants in the eThekwini municipality ".

Ms Young, is requested to submit a copy of her FRC / IREC approved proposal along with proof of her M.Tech:Chiropractic registration to the Clinic Administrators before she starts with her research in order that any special procedures with regards to her research can be implemented prior to the commencement of her seeing patients.

Thank you for your time.

Kind regards

Dr L O'Connor
Head of Department:
Chiropractic

Dr Desiree Varatharajullu
Clinic Director: Chiropractic Day
Clinic: Chiropractic

Cc: Mrs Linda Twiggs: Chiropractic Day Clinic
Dr L O'Connor: Supervisor

APPENDIX D: MOU BETWEEN RESEARCHER, DUT AND CUSHION DEVELOPER

Durban University of Technology

Memorandum of understanding between:

The "RESEARCH INSTITUTION' - Durban University of Technology (this includes the respective research student and research supervisor, Department of Chiropractic. The Faculty of Health Sciences Research Committee, The Institutional Research Committee and any other related DUT employees.

AND

The "MANUFACTURER" - Ridgeback™ (including all members, employees, associates).

This Memorandum of Understanding pertains to the following research project and must be read in conjunction with:

APPENDIX A-Detailed Research Proposal (PG2a)
APPENDIX B-Durban University of Technology Research Committee Research Ethics Policy and Guidelines

Title of the study:
The effect of a thoracic spine postural cushion on seated spinal posture in asymptomatic participants in the eThekwini municipality.

Research Supervisor: Dr. L. O'Connor (Dept. of Chiropractic and Somatology at Durban University of Technology)

This study is a Master's Mini Dissertation conducted in partial compliance with the Master's Degree in Technology in the Department of Chiropractic - Faculty of Health Sciences - Durban University of Technology. This study will obtain ethical approval from the Faculty of Health Sciences Research & Ethics Committee (FRC) of Durban University of Technology.

Please be aware the brand name will be available to the participants and included in the letters of information as well as the dissertation.

Section 1-Funding of the study and financial commitment

1.1 A research allowance of R5000.00 will be awarded by the Dept. Post-graduate Development & Support –The details of the funds approved are described in Section A of the Research Proposal (PG2a) attached i.e. the budget as is outlined in the PG2a.

1.2 The 'MANUFACTURER'- acknowledges that THE RESEARCH INSTITUTION' will have no financial obligations or commitments to the 'MANUFACTURER' whatsoever as a result of conducting this study.

1.3 The 'MANUFACTURER'- may not award or incentivize the study or its related parties in any manner whatsoever, nor remunerate, award or offer any financial or other donation or gift to any of those involved with the study.

1.4 It is noted, however, that the 'MANUFACTURER' will be sponsoring a RidgeBack™ cushion to 'THE RESEARCH INSTITUTION' for the purposes of completing the research project referred to in this document.

Section 2-Academic processes and outcome

2.1 The FRC has approved the above mentioned Research Supervisor who in conjunction with the Research Student are the sole contributors to the academic content, procedures, results and findings of the study based on the prescribed data analysis in the research proposal, barring amendments required by the approved research examiners appointed by the RESEARCH INSTITUTION.

2.2 The 'MANUFACTURER' acknowledges that the findings upon completion of the study (as determined by the Research Student and Research Supervisors and according to the protocol stated in the attached research proposal) will be final and non-negotiable.
The 'MANUFACTURER' acknowledges further that it has no authority over the outcome of this study and may not influence the findings or the reporting thereof in any matter.

2.3 Any modification or deviation from the approved research proposal, must be applied for in writing, endorsed by both the Research Student & Supervisors and Head of Department before serving before the FRC/IREC, the final say therein will be determined by the FRC/IREC.

2.4 The 'MANUFACTURER' acknowledges that it may not influence or make any change to the approved research protocol/proposal.

Section 3-Publication of findings

3.1 The findings and outcome of the above mentioned study remain the intellectual property of the 'RESEARCH INSTITITION' indefinitely. The study will be published in the format of a hard bound dissertation which will be placed in the DUT library.

3.2 Publication of the findings of this study in a journal or other scholarly medium will be at the discretion of the Research student and /or Research Supervisors who will determine the appropriate medium and place of publication as well as content of the publication. Authorship of any scholarly output originating from this study of the Research Student and Research Supervisors and other collaborators appointed by the Research Student and/or the Research Supervisors. Such scholarly publication must include the names of the Researcher and the Research Supervisor as well as the 'RESEARCH INSTITUTION'.

3.3 Any reference whatsoever to the findings of this study if quoted or mentioned in any format must make formal reference to the respective dissertation, its official title, and its author(s) and the owners of the intellectual property thereof i.e. the 'RESEARCH INSTITITION'.

3.4 Any reference whatsoever to any secondary publication arising from this original study must make formal reference to the respective dissertation its official title and its author(s) and the owners of the intellectual property thereof i.e. the 'RESEARCH INSTITUTION'

3.5 The 'MANUFACTURER' may make reference to the outcome of this study in the prescribed manner mentioned in section 3.3 and 3.4 undertaking 3.1 and 3.2.

Section 4-Indemnity

4.1 The Research Student, the Research Supervisor and the research facilities and its staff are duly covered by the 'RESEARCH INSTITUTION' insurance policy pertaining to public liability, injury or harm which may occur as a result of conducting this study.

Section 5- Ethical considerations

5.1 Ethical clearance of the proposed study will be granted by the DUT IREC (such ethical clearance will become invalid should there be any deviation from the approved research methodology described in the research proposal attached).

5.2 The 'MANUFACTURER' undertakes to abide by the DUT Research Committee Research Ethics Policy and Guidelines (APPENDIX B).

5.3 In addition to 5.2 the 'MANUFACTURER should note and refer to **Section 1, 2 & 3** of this document.

I Sue Randall **(name of representative of the 'MANUFACTURER')** hereby in my official capacity as representative of **RidgeBack™** hereby agree to abide by the regulations stated in this memorandum of understanding.

Signature of official representative of **RidgeBack™** — Date 24/04/2019

I SIBUSISO MOYO **(name of representative of the 'THE RESEARCH INSTITUTION')** hereby in my official capacity as representative of **Durban University of Technology** hereby agree to abide by the regulations stated in this memorandum of understanding

Signature of official representative of **Durban University of Technology** — Date 29/4/19

I **Miss Kerry-Lee Young,** in my capacity as **the research student** hereby agree to abide by the regulations in this memorandum of understanding between the **RidgeBack™** (the "MANUFACTURER") and **Durban University of Technology** (the "RESEARCH INSTITUTION")

Signature of research Student — Date 29/04/2019.

APPENDIX E: ADVERTISEMENT

Are you sitting correctly at your desk?

Would you like your posture to be assessed?

If you do not experience neck/back pain and have had no spinal injuries, would you like your

posture to be assessed for FREE?

Call to book your appointment today

with Kerry-Lee Young:

DUT Chiropractic Clinic – 031 373 2205

APPENDIX F: INFORMED CONSENT FORM

CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Kerry-Lee Young (name of researcher), about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: ___087/19___,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

______________________ ___________ ______ ________________

Full Name of Participant **Date** **Time** **Signature / Right Thumbprint**

I, Kerry-Lee Young (name of researcher), herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

______________ ___________ ________________
Full Name of Researcher **Date** **Signature**

______________ ___________ ________________
Full Name of Witness (If applicable) **Date** **Signature**

______________ ___________ ________________
Full Name of Legal Guardian (If applicable) Date **Signature**

APPENDIX G: LETTER OF INFORMATION

Dear Participant

I would like to welcome you into my study and thank you for taking the time to participate.

Title of the Research Study: The effect of a thoracic spine postural cushion on seated spinal posture in asymptomatic participants in the eThekwini municipality.

Principal Investigator/s/researcher: Kerry-Lee Young (BTech: Chiropractic)

Co-Investigator/s/supervisor/s: Dr Laura O'Connor (M.Tech: Chiropractic)

Brief Introduction and Purpose of the Study: Incorrect seated posture is a major cause of back pain and while there are many studies done on lumbar supportive cushions, there is currently no research done on a thoracic supportive cushion in the eThekwini municipality.

The aim of this study is to determine the effect of a thoracic spine postural cushion on seated posture by measuring the angles of anterior head carriage and thoracic kyphosis using the Posture Pro Software System. Participants will be seated at an ergonomically setup workstation, specifically suited to them and the study will be carried out at the Durban University of Technology Chiropractic Day Clinic.

Outline of the Procedures: You will be set up at a workstation while a tripod holding a camera faces towards your workstation. First, you will be seated without the thoracic support cushion (RidgeBack™). Round, red markers will be placed on the appropriate areas of your body. You will commence a reading task on the screen placed in front of you, while the researcher takes a series of photographs of you over a two-minute period. After uploading photographs of yourself onto a computer system, a photo editing software will be used to place a black circle over your face, preventing identification, thus ensuring protection of your rights and welfare. After your task is completed, you will be asked to walk around the room for 1 minute while the researcher sets up the office chair with the RidgeBack™. You will then repeat your reading task while the researcher takes another series of photographs over a two-minute period. After each task is complete, you will be asked to answer a "comfort scale questionnaire" assessing the comfort of the office chair and your work environment, with and without the support cushion.

Risks or Discomforts to the Participant: There are no risks/discomforts expected with your participation in this study.

Benefits: Your full co-operation will assist in expanding of knowledge of office ergonomics, posture and related musculoskeletal pain. This study should open doors to allow for further intervention studies to improve the office environment and job satisfaction.

Reason/s why the Participant May Be Withdrawn from the Study: Your participation in this study is voluntary and you are free to withdraw from this study at any time without any adverse consequences.

Remuneration: There will be no remuneration (payment) for participating in this study.

Costs of the Study: You will not be expected to pay towards any costs of the study.

Confidentiality: All information is confidential and the results will be used for research purposes only. All participants will remain anonymous and confidential. Participants will write their names on the observational checklist and the comfort scale to ensure the researcher has the correct questionnaire to match the observational checklist. The researcher will document the information for statistical analysis. No names will be documented and no information will be identifiable to you. All information obtained will be kept in complete confidence and the overall results of the study will be made available in the Durban University of Technology library in the form of a dissertation. Informed consent forms (Appendix B) along with any recorded data from the study will be kept in the Chiropractic Department under lock and key for five years after which they will be destroyed. After uploading photographs of participants onto a computer system, a photo editing software will be used to place a black circle over the faces of the participants, preventing identification of the participants, thus ensuring the protection of the rights and welfare of the participants. This will be stored safely on flash drive which only the researcher will have access to and deleted after 5 years. Please do not hesitate to ask any questions on any aspect of this study.

Research-related Injury: Participation in this study will not cause any injury to you.

Persons to Contact In case of Emergency or Any Queries:

Please contact the researcher Kerry-Lee Young, 073 371 4447, my supervisor Dr Laura O'Connor (Ext 2923) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the DVC: Research, Innovation and Engagement Prof S Moyo on 031 373 2577 or moyos@dut.ac.za.

APPENDIX H: OBSERVATIONAL CHECKLIST

Name:____

OFFICE AREA SET UP	YES	NO	COMMENTS
1.Top of screen just below eye level?			
2. Monitor directly in front of worker?			
3. Distance to monitor is 45-60cm? (eyes to screen)			
4. Seat height allows thighs to be parrallel with floor?			
5. Foot rest available to support feet?			
Is the foot rest used?			
6. Chair aligned with masking tape marked on floor?			

PARTICIPANT POSTURE	YES	NO	COMMENTS
1. Thighs parallel to floor?			
2. Feet supported by floor/footrest?			
3. Thoracic spine supported by cushion?			
4. Buttock pushed to back of seat?			
5. Arms relaxed on arm rest?			
6. Elbows approximately at 90 degrees?			
7. Shoulders are relaxed?			
8. Neck is neutral? (no elevation of chin)			
9. Bottom border of cushion resting on chair seat?			

CAMERA SET UP	YES	NO	COMMENTS
1. Masking tape on the floor 1 meter away from office chair?			
2. Two legs of tripod are at the masking tape 1 meter away from chair?			
3. Camera is in a portrait orientation?			
4. Level used to level camera?			
5. Camera set on camera mode with flash?			

(Bohr 1998)

APPENDIX I: OBSERVATIONAL CHECKLIST

Name:____

Rate your level of comfort while performing the reading task.

☐ Not Comfortable At All

☐ Not Very Comfortable

☐ More or Less Comfortable

☐ Very Comfortable

☐ Totally Comfortable

APPENDIX J: POSTURE EVALUATION

Name:____

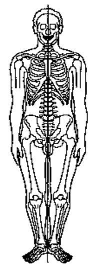
POSTURE EVALUATION

NAME: AGE: SEX: HEIGHT: WEIGHT: DATE:

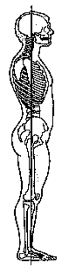
Body type: Ectomorph / Mesomorph / Endomorph / Slight Build / Medium Build / Heavy Build

Uncorrected Standing A | Corrected (Talus in Neutral) Standing B | Postural Deformity Corrected C

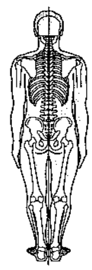
ANTERIOR VIEW	Comments:
Head (aligned, forward, flexed, extended)	
Mandible (resting position, retracted)	
Shoulders (level, uneven)	
Rib cage (symmetric, asymmetric)	
Scoliosis (left, right, lumbar, thoracic, cervical)	
Pelvis (level, anterior/posterior tilt)	
Hips (coxa vara, coxa valga, anteversion, retroversion)	
Femurs (alignment, torsion)	
Knees (level, genu varum, genu valgum)	
Patellar position	
Tibias (alignment, torsions)	
Ankles (inversion, eversion)	
Rearfoot/forefoot alignment	
Feet (pes cavus, pes planus, supination/pronation)	
Toes (alignment, deformities)	
Leg length	



LATERAL VIEW	Comments:
Head (forward, flexed/extended)	
Mandible (resting, protracted/retracted)	
Scapulae (winging, elevation/depression)	
Thoracic kyphosis (increased/decreased)	
Lumbar lordosis (increased/decreased)	
Pelvis (anterior/posterior tilt)	
Knees (hyperextension/flexion)	
Feet (longitudinal arch)	



POSTERIOR VIEW	Comments:
Head (alignment, tilt)	
Shoulders (level)	
Scapulae (bilateral symmetry)	
Spine C-1 to sacrum (rotations, deviations)	
Pelvis (level, tilt)	
Sacrum (level at base and inferior lateral angles)	
Hips (level, uneven)	
Knees (creases level/uneven)	
Leg (rearfoot alignment)	
Ankles (inversion/eversion)	
Calcaneal position (inverted/everted)	



Pertinent Medical History:

Pertinent Radiographic Findings / Other Tests:

(Magee 2013)