Normal craniovertebral angle range in asymptomatic Black South African females: A pilot study

By

Reenu Antony

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

_____________________________ Date: 26/09/2022

Candidate: Reenu Antony

Approved for Final Submission

_____________________________ Date: 26 September 2022

Supervisor: Dr Desiree Varatharajullu

PhD: Health Sciences M.Tech: Chiropractic

Advanced Diploma: Management Sciences (Business Administration)

_____________________________ Date: 26/09/2022

Co -Supervisor: Dr Yomika Venketsamy

M.Tech:Chiropractic (DUT)

M.Phil: Biomedical Forensic Science (UCT)

DEDICATION

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"Fear of an obstacle is always a

bigger problem than the obstacle itself."

- Nuel E. Dominics

ABSTRACT

Introduction: Forward head posture (FHP) has become more prevalent in modern times and is described as carrying the head anterior to the centre of the shoulder. As the head moves forward, the centre of gravity shifts. To compensate for this shift, the upper body shifts backward to maintain balance, which eventually leads to fatigue and subsequent myofascial pain when this position is maintained for prolonged periods of time. The craniovertebral angle (CVA) measures the degree of FHP and is formed between a horizontal line passing through C7 of the cervical spine and a line extending from the tragus of the ear to C7 spinous process. Previous studies have concluded that a smaller CVA indicates FHP. Global studies have reported possible associations between FHP and postural related musculoskeletal complaints and chronic pain especially in Black females in South Africa. Studies have also reported various therapies that would increase CVA, thus correcting or improving FHP to manage or prevent the negative impacts associated with FHP. Normal cervical spine radiographic parameters may differ in males and females, and among the various South African ethnic groups, suggesting that normal CVA ranges may also differ among the sexes and various ethnic groups. A generally accepted normal CVA range to accurately measure and quantify FHP warrants the need to determine a standardised and normalised range for CVA for Black females in South Africa, so as to a set reference point for clinical practice and research.

Aim: The aim of this study was to determine a normalised range for CVA among Black South African females to be utilised for further studies and clinical practice.

Method: This was a pilot study that used a quantitative, non-experimental, observational design. Black South African females between the ages of 18 and 45 years were recruited through advertisements placed in and around the Durban University of Technology and greater Durban area and via word of mouth. A total of 51 participants were recruited. Symptomatic participants and participants who presented with FHP on visual assessment were excluded from the study. Markers were placed at the tragus of the ear and at C7 spinous process. Lateral photographs were taken with a digital camera of the participants in seated and standing positions. The Posture Pro Software Analysis was used to measure CVA from the photographs obtained. The data captured were sent to a statistician for statistical analysis.

Results: The mean CVA while seated was 41.88 degrees, with a standard deviation of 5.23; and the mean CVA while standing was 37.15 degrees, with a standard deviation of 4.30. The paired t-test result showed a significant difference between CVA in seated and standing position ($p < 0.001$). Furthermore, the correlation between BMI and CVA seated and standing had a significant weak positive correlation of 0.320 ($p<0.05$) and 0.391 ($p<0.01$) respectively.

Conclusion: The results indicated that CVA differs significantly between the seated and standing position and that CVA in the seated position was more increased when compared to the standing position.

Keywords: Craniovertebral angle, forward head posture, observational assessment.

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List of Definitions

Abnormal Posture: Any position that results in an increase in the amount of stress applied to the joints (Magee 2014:1017).

Body Mass Index: A person's weight in kilograms divided by the square of height in metres (Body Mass Index, 2021: para. 1).

Chiropractic Adjustment: A specific form of joint manipulation that is characterised by a low amplitude, high velocity thrust (Bergman and Peterson 2011:84-90).

Chiropractor: A primary care physician with an emphasis on neuromusculoskeletal diagnosis and treatment by means of manual adjustments to restore mobility, amongst other adjunct therapies (Chiropractor Definition, 2022: para.1-4).

Clinical Biomechanics of Posture: Conservative approach to patient rehabilitation that entails translation and rotation exercises, and that can be coupled together with spinal adjustments and traction to restore normal posture (Ferrantelli *et al*. 2005:205).

Correct Posture: The position that causes the least amount of stress applied to the joints (Magee 2014:1017).

Craniovertebral Angle: Formed between a horizontal line passing through C7 of the cervical spine and a line extending from the tragus of the ear to C7 spinous process (Kim, Kim and Son 2018:310).

Ergonomics: A body of knowledge about human abilities, limitations and characteristics that are relevant to design (Stack, Ostrom and Wilhelmsen 2016:6).

Ergonomic Design: The application of the ergonomics to the design of tools, machines, systems, tasks, jobs, and environments for safe, comfortable, and effective use for people (Stack, Ostrom and Wilhelmsen 2016:6).

Forward Head Posture: A position whereby the head is anteriorly displaced from a vertical reference line that passes through the lobe of the ear to the tip of the shoulder in the sagittal plane (Subbarayalu 2016:144).

Posture: The alignment of different joints of the body in relation to one another (Magee 2014:1017).

Microtrauma: An injury resulting from repetitive stress to tissues which is characterised by an insidious onset of symptoms (Donatelli *et al*. 2004:89).

Spinal manipulation therapy: A specific 'hands-on' clinical approach used by a variety of health practitioners, such as chiropractors, to treat musculoskeletal pain (Sampath *et al*. 2015:819).

Text Neck: A term coined by Dr Dean Fishman (US Chiropractor) used to describe the repetitive stress or overuse injury that may occur when looking down at an electronic device (Neupane, Ali and Mathew 2017:141).

List of Symbols and Abbreviations

°:	Degree
BP:	Blood Pressure
BMI:	Body Mass Index
cm:	Centimetres
CDC:	Chiropractic Day Clinic
CVA:	Craniovertebral Angle
DBP:	Diastolic Blood Pressure
DUT:	Durban University of Technology
FHP:	Forward Head Posture
ICHD-3:	International Classification of Headache Disorders, third edition
IFC:	Interferential Current
IREC:	Institutional Research Ethics committee
Kg:	Kilogram
Kg/m^2:	Kilogram per metre square
m:	Metres
MVA:	Motor Vehicle Accident
***n*:**	Sample Size
SBP:	Systolic Blood Pressure

SD: Standard Deviation

SMT: Spinal Manipulation Therapy

SPSS: Statistical Package for the Social Sciences

TMD: Temporomandibular Disorders

TMJ: Temporomandibular Joint

US: United States

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This introductory chapter provides an overview of the study and contextualises the research, which includes the background to the study, the research problem, aims, objectives and rationale for the study.

1.2 BACKGROUND TO THE STUDY

Posture refers to the alignment of different joints of the body in relation to one another (Magee 2014:1017). According to Magee (2014:1017), correct posture is the position that causes the least amount of stress applied to the joints, and abnormal posture is any position that results in an increase in the amount of stress applied to the joints. Forward head posture (FHP) is a common abnormal posture seen in patients and has been described as a position whereby the head is anteriorly displaced from a vertical reference line that passes through the lobe of the ear to the tip of the shoulder in the sagittal plane (Subbarayalu 2016:144). The craniovertebral angle (CVA) measures the degree of FHP and is formed between a horizontal line passing through C7 of the cervical spine and a line extending from the tragus of the ear to C7 spinous process (Kim, Kim and Son 2018:310).

Previously, visual assessments and lateral radiographs were done to measure FHP and CVA (Subbarayalu 2016:145). Given the advances in technology, lateral photographs and computer software have been developed, thereby making it more reliable to quantify these measurements (Subbarayalu 2016:144-145). The Posture Pro Software Analysis (developed by Ventura Design©) is easily accessible, less time consuming and can be utilised by clinicians tomeasure the progression of a pathology or the effectiveness of a treatment plan (Hébert- Losier and Rahman 2018:483-485).

1.3 RESEARCH PROBLEM, AIMS AND OBJECTIVES

1.3.1 Research Problem

Forward head posture is a common postural abnormality seen in individuals. Advances in technology, the usage of smartphones, computers and other hand-held devices are set to increase, which may subsequently result in a higher incidence of FHP. Neck pain has been shown to be highest among the Black population in the greater Durban area (Ndlovu 2006:103; Slabbert 2010:5; Muchna 2011:86). Although research studies have investigated cervical spine parameters on radiographs in South African ethnic groups, there is paucity in the literature with respect to an accepted CVA range norm. Therefore, this study will try to address this paucity and determine the feasibility for larger studies to be conducted for future research.

1.3.2 Aim

The aim of this study is to determine a standardised range for craniovertebral angle among Black South African females to be used for clinical and research reference.

1.3.3 Objectives

1. To measure CVA in asymptomatic Black South African female participants (standing and seated) using the Posture Pro Software Analysis.
2. To compare CVA measurements taken in standing and seated positions.

1.4 RATIONALE

Globally, various studies have reported possible associations between FHP and non-specific neck pain and upper quadrant musculoskeletal pain (Akodu *et al*. 2015:16; Jung *et al*. 2016:186; Kim and Kim 2016:2929). In South Africa, although there is a paucity in the literature on the prevalence of FHP, the prevalence of neck pain was reported to be highest among the Black population (50%), followed by the White population (45%) and the Indian population (36.8%) in the greater Durban area (Ndlovu 2006:103; Slabbert 2010:5; Muchna 2011:86).

Previous literature has shown a high prevalence of obesity in South Africa with more than 29% of men and 56% of women classified as overweight or obese (Cois and Day 2015:43). Black South African women were found to have had the highest prevalence of obesity (58.5%), which may subsequently increase the risk of musculoskeletal complaints in this population (Goedecke, Jennings and Lambert 2006:65-66; Cois and Day 2015:42-44; Gradidge 2017). Zungu and Ndaba (2009:26) reported that 28.2% of office workers complained of pain localised mostly to regions of the neck, shoulder, and wrist. Non-specific neck pain is often the cause of working days lost (Zungu and Ndaba 2009:25) and addressing factors associated with neck pain will help reduce the onset and intensity of work-related neck pain and the absenteeism from work.

According to Lee *et al*. (2018: 859-860) and Kamerman *et al*. (2020:1629), females are more at risk to postural related musculoskeletal complaints and chronic pain. Roopnarian (2011:29-42) and Naicker (2013:32-44) investigated normal cervical spine parameters on radiographs in males and females and found that normal cervical spine radiographic parameters were reported to differ among the South African ethnic groups (Roopnarian 2011:29-42; Naicker 2013:32-44) suggesting that normal CVA ranges may also differ among the various ethnic groups.

Based on these findings, there is yet to be a generally accepted normal CVA range to accurately measure and quantify FHP, which warrants the need to determine a standardised and normalised range for CVA for the various ethnic groups in South Africa, to set a reference point for clinical practice and research.

Studies have reported various treatments such as spinal manipulative therapy and mobilisation, interferential current therapy, myofascial trigger point release techniques, kinesio taping and exercise increase CVA, thus correcting or improving FHP to manage or prevent the negative impacts associated with FHP (Morningstar, Strauchman and Weeks 2003:51; Gong 2015:1611; Kim *et al*. 2016:31 and Choi *et al*. 2018:398).

1.5 THE HYPOTHESIS

H_1: A significant difference exists between CVA whilst seated and CVA while standing.

H_0: A null hypothesis was set which stated that CVA while seated is equal to CVA while standing.

1.6 CONCLUSION

Therefore, this study is focused on obtaining a normal CVA range among Black South African females, as a set reference point would enhance the treatment (including prophylactic treatment) of FHP, as it has been associated with musculoskeletal pain, which can be self-limiting and results in an economic burden (Akodu *et al*. 2015:16).

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter provides a brief overview of postural development and the relevant anatomy. Additionally, it contextualises the current literature regarding craniovertebral angle, in relation to forward head posture and some of its possible implications, thus, highlighting gaps in the literature. The literature that was reviewed was sourced from the following databases: anatomy textbooks, Google Scholar, ScienceDirect, ResearchGate, PubMed, JSTOR, EBSCOhost and DUT Summons.

2.2 POSTURAL DEVELOPMENT

Posture refers to the alignment of different joints of the body in relation to one another, and where the position of each joint has an effect on the position of the other joints (Magee 2014:1017). Typically, ideal static postural alignment viewed laterally is defined as a straight line that passes through the earlobe, the bodies of the cervical vertebrae, the tip of the shoulder, midway through the thorax, through the bodies of the lumbar vertebrae, slightly posterior to the hip joint, slightly anterior to the axis of the knee joint and anterior to the lateral malleolus (Magee 2014:1017).

According to Magee (2014:1017), correct posture is the position that causes the least amount of stress applied to the joints which results in minimal muscle activity required to maintain that position. An abnormal posture is any position that results in an increase in the amount of stress applied to the joints, resulting in repetitive microtrauma over a prolonged period of time, which may subsequently result in degeneration of the joints. The effects of abnormal posture may be worsened if the muscles are weak or if muscle imbalance is present, and if joints are hypomobile or hypermobile; as such, postural deviations may not always cause symptoms, but they may occur over time (Magee

2014:1017). Abnormal posture can be caused by poor postural habit, muscle imbalance, pain, respiratory conditions, general weakness, excess weight, loss of proprioception, muscle spasm and structural deformities (Magee 2014:1017).

The whole spine at birth is flexed or concave anteriorly, referred to as primary curves, which are retained by the thoracic spine and the sacrum; the cervical spine and lumbar spine develop into secondary curves as the child grows up (Magee 2014:1017). Around the age of three months when the child starts to lift the head, the cervical spine becomes convex anteriorly, developing a cervical lordosis. At around six to eight months, the lumbar spine becomes convex anteriorly when the child begins to sit up and walk (Magee 2014:1017). These secondary curves begin to disappear and return to a flexed curve in the elderly due to degeneration (Magee 2014:1017).

According to Magee (2014:157), the normal cervical lordosis is 30-40°, the normal thoracic kyphosis is 40° and the lumbar lordosis is 45°. **Figure 2.1** depicts the spinal curvature in the sagittal plane.

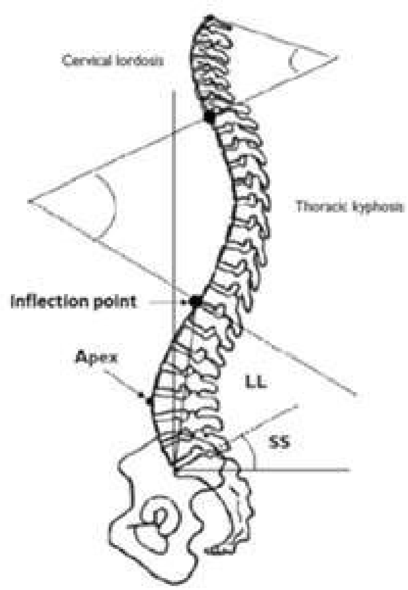

Figure 2.1: Sagittal plane curvatures across the regions of the vertebral column (Le Huec et al. 2015:89)

2.3 ANATOMY OF THE NECK REGION

The neck is the transitional area between the base of the cranium superiorly and the clavicles inferiorly and is responsible for maintaining head posture while allowing a significant amount of mobility (Moore, Dalley and Agur 2014:982; Magee 2014:1017). Therefore, this is an area that is vulnerable to injury as the neck connects the heavy head to the stable thorax and stability in this region is forfeited for mobility (Moore, Dalley and Agur 2014:982; Magee 2014:1017). The skeleton of the neck is composed of the cervical vertebrae, hyoid bone, manubrium of the sternum and clavicles (Moore, Dalley and Agur 2014:982). The cervical spine comprises of seven cervical vertebrae, which are made up of a vertebral body and a posterior arch, and is located between the cranium and the thoracic vertebrae (Moore, Dalley and Agur 2014:982).

The cervical spine can be divided into the cervicoencephalic or cervicocranial region (C0 to C2) and the cervicobrachial region (C3 to C7). Injuries to the cervicocranial region may involve the brain, brainstem, and spinal cord, due to its proximity, which may result in headaches, poor concentration, fatigue, vertigo, cognitive dysfunction, cranial nerve dysfunction and hypertonia of the sympathetic nervous system (Moore, Dalley and Agur 2014:446). Vertebrae C3 to C7 are referred to as typical vertebrae and vertebrae C1, C2 and C7 are referred to as atypical vertebrae as they have unique features that distinguish them from the normal features that are seen in typical vertebrae (Moore, Dalley and Agur 2014:446).

The C1 vertebra is referred to as the atlas and is unique in that it does not have a body or a spinous process; the C2 vertebra is referred to as the axis and it is the strongest of the cervical vertebrae (Moore, Dalley and Agur 2014:446). The distinct feature of the C2 vertebra is the odontoid process/dens, which is a superior projection of its body that is encircled by the atlas and serves as a pivot for which the head rotates about (Moore, Dalley and Agur 2014:446). Vertebrae C7 is characterised by a long spinous process, referred to as the vertebra prominence, and is the most prominent spinous process in about 70% of the population (Moore, Dalley and Agur 2014:446).

The neck houses vital structures, including the trachea, thyroid gland, oesophagus, carotid and jugular blood vessels (carotid artery is the main arterial blood flow and the jugular veins are responsible for venous drainage to the head and neck), spinal cord, nerves, brachial plexus and cervical lymph nodes, which are illustrated in **Figure 2.2**. These structures further increase the vulnerability of this region and any injury or abnormalities may pose a risk to the individual (Moore, Dalley and Agur 2014:982).

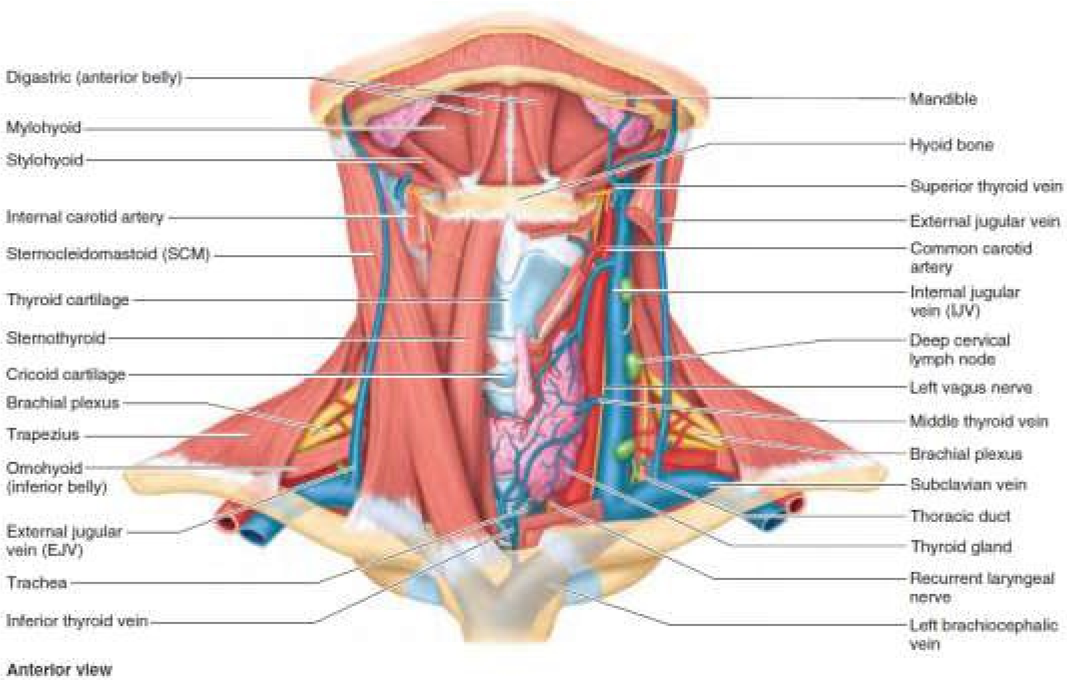

Figure 2.2: Dissection of the anterior neck presenting the vital structures housed within the neck. (Reproduced with permission Moore and Dalley, Clinically Oriented Anatomy, 5th edition, Wolters Kluwer Health Inc., 2006)

2.3.1 Review of the Relevant Muscles Associated with Muscle Imbalance and Forward Head Posture

The following **Table 2.1** summarises the elongated and underactive muscles associated with muscle imbalance and forward head posture.

Table 2.1: Overview of the elongated/underactive muscles found in forward head posture

Name	Origin	Insertion	Action
Longus Capitus	Anterior tubercles of C3-C6 tranverse processes	Basilar aspect of the occiput	Bilaterally – Head flexion Unilaterally – Ipsilateral head rotation
Longus Coli	Superior portion: Anterior tubercles of transverse processes of C3-C5 Intermediate portion: Anterior aspect of C5-T3 vertebrae Inferior portion: Anterior aspect of T1-T3 vertebrae	Superior portion: Anterior tubercle of C1 vertebra Intermediate portion: Anterior aspect of C2-C4 vertebrae Inferior portion: Anterior tubercles of transverse processes of C5-C6	Bilaterally – Neck flexion Unilaterally – Ipsilateral neck lateral flexion and contralateral neck rotation
Erector Spinae muscles (spinalis, longissimus and iliocostalis)	Spinalis capitis: C7-T1 spinous processes Spinalis colli: C7-T1 spinous processes and nuchal ligament Spinalis thoracis: T11-L2 spinous processes Longissimus capitus: C4-T5 tansverse processes Longissimus colli: T1-T5 transverse processes Longissimus thoracis (thoracic part): L1-L5 vertebrae, sacrum and posterior iliac crest Iliocostalis capitus: Angle of ribs 3 to 6 Iliocostalis thoracis: Angle of ribs 7 to 12	Spinalis capitis: Midline of occiput Spinalis colli: C2-C4 spinous processes Spinalis thoracis: T2-T8 spinous processes Longissimus capitus: Mastoid process of temporal bone Longissimus colli: C2-C6 transverse processes Longissimus thoracis (thoracic part): Thoracic vertebrae and inferior six ribs Iliocostalis capitus: C4-C6 transverse processes Iliocostalis thoracis: Angles of ribs 1-6 and transverse process of C7	Bilaterally – Extension of the spine Unilaterally – Ipsilateral lateral flexion of the spine
Trapezius (middle and lower)	Spinous process of C7-T12 vertebrae	Lateral 3rd of clavicle, acromion and spine of scapula	Depress scapula
Rhomboid Major	Spinous process of T2-T5	Medial border of scapula	Retracts and rotates scapula; fixes scapula to the thoracic wall
Rhomboid Minor	Nuchal ligament and spinous process of C7-T1	Medial border of scapula	Retracts and rotates scapula; fixes scapula to thoracic wall
Serratus Anterior	External surface of lateral part of the 1st to 8th rib	Anterior aspect of the medial border of the scapula	Protracts scapula

Source: Magee 2014:165, 1023; Moore, Dalley and Agur 2014:982; Simons, Travell and Simons 1999:278-328, 397-415.

The common musculature associated with muscle imbalance and forward head posture are illustrated in **Figure 2.3**.

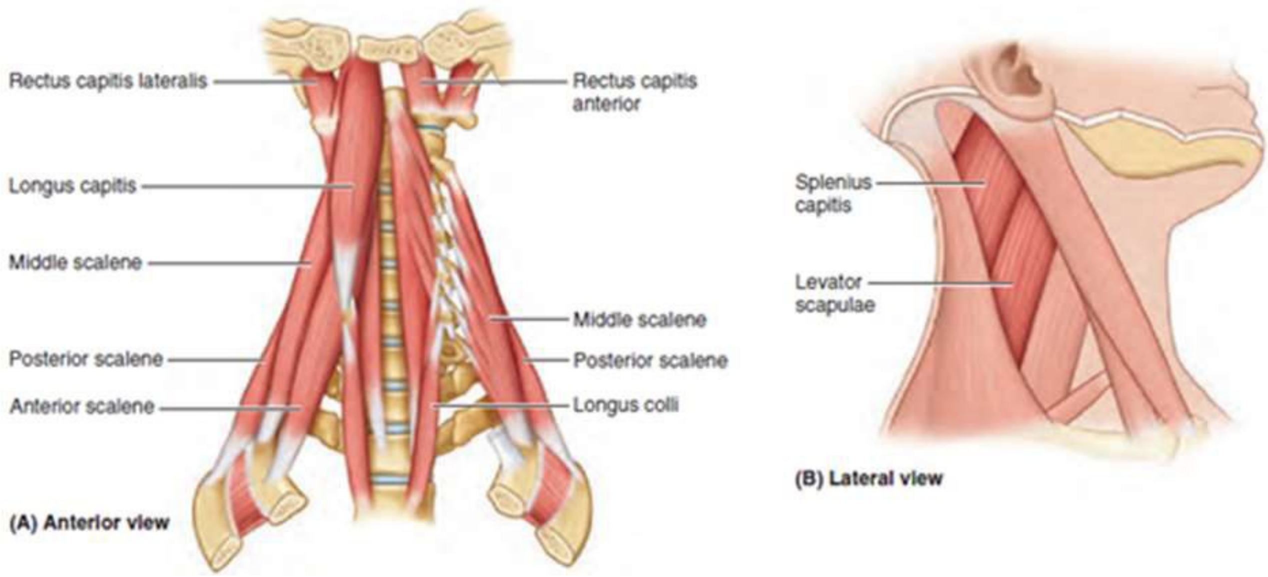

Figure 2.3: Prevertebral muscles. (Reproduced with permission Moore and Dalley, Clinically Oriented Anatomy, 5th edition, Wolters Kluwer Health Inc., 2006)

The following **Table 2.2** summarises the shortened and overactive muscles associated with muscle imbalance and forward head posture.

Table 2.2: Overview of the shortened/overactive muscles found in forward head posture

Name	Origin	Insertion	Action
Suboccipitals	Occipital bone	C1-C2 spinous process	Head rotation, lateral flexion and extension
Sternocleido mastoid	Lateral surface of mastoid process of temporal bone and lateral half of superior nuchal line	Sternal head: anterior surface of manubrium of Sternum Clavicular head: superior surface of medial third of clavicle	Unilaterally – Neck lateral flexion and rotation Bilaterally – Neck extension and flexion
Anterior Scalene	Transverse processes of C3–C6 vertebrae	1st rib	Neck lateral flexion; elevates 1st rib during forced inspiration
Middle Scalene	Posterior tubercles of transverse processes of C5–C7	Superior surface of 1st rib	Neck lateral flexion; elevates 1st rib during forced inspiration
Posterior Scalene	Posterior tubercles of transverse processes of C5–C7	External border of 2nd rib	Neck lateral flexion; elevates 2nd rib during forced inspiration
Pectoralis major	Medial half of clavicle, sternum and superior six costal cartilages	Lateral lip of intertubercular groove of the humerus	Adducts and medially rotates humerus, draws scapula anteriorly and inferiorly
Pectoralis Minor	Ribs 3-5 (near costal cartilages)	Medial border and superior aspect of coracoid process of scapula	Stabilizes scapula by drawing it inferiorly and anteriorly against the thoracic wall
Levator Scapular	Posterior tubercles of C1-C4 transverse process	Superior part of medial border of scapula	Elevates scapula
Trapezius (upper portion)	Medial 3rd of superior nuchal line and external occipital protuberance	Lateral 3rd of clavicle, acromion and spine of scapula	Elevation and rotation of the scapula

Source: Magee 2014:165, 1023; Moore, Dalley and Agur 2014:982; Simons, Travell and Simons 1999:278-328, 397-415.

Figure 2.4 depicts the pectoralis muscles which are associated with muscle imbalance and forward head posture and are commonly found to be shortened and overactive.

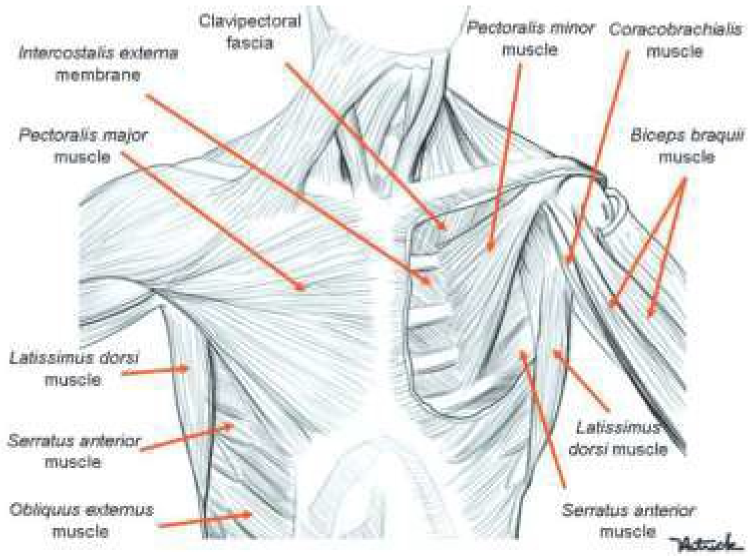

Figure 2.4: Muscles of the trunk (Macéa and Fregnani 2006:692)

2.3.2 Craniovertebral Angle

The craniovertebral angle was first described in 1973 by Wickens and Kipputh (cited by Grimmer-Somers, Milanese and Louw 2008:512) and has become a widely acknowledged indicator of head and neck posture, more specifically for FHP. CVA is described as a horizontal line passing through C7 of the cervical spine and a line extending from the tragus of the ear to C7 spinous process (Grimmer-Somers, Milanese and Louw 2008:512; Kim, Kim and Son 2018:310), as illustrated in **Figure 2.5**.

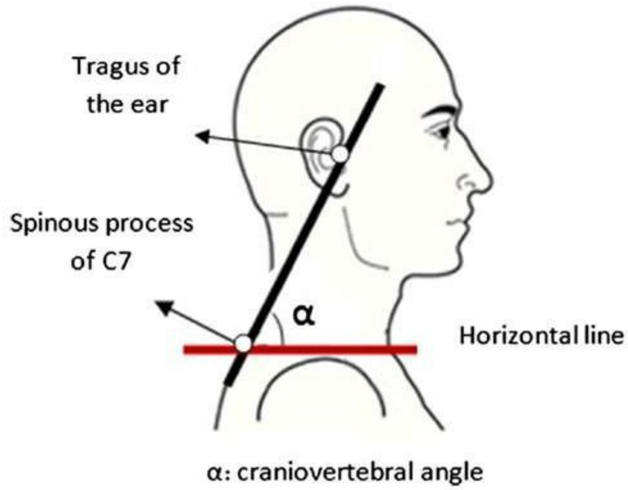

Figure 2.5: Craniovertebral angle (Fard et al. 2016:3578)

Smaller CVA measurements have been associated with FHP and resultant musculoskeletal pain (Yip, Chiu and Poon 2008:151; Kim, Kim and Son 2018:309-313; Lee *et al*. 2018: 859-860). Cervical posture angles have been reported by means of radiographic digital imaging (Grimmer-Somers, Milanese and Louw 2008:512). However, such methods proved to be time-consuming and resulted in unnecessary radiation exposure (Garett, Youda and Madson 1993:155-156). Given the advances in technology, computer software has been developed, thereby making it more reliable, less time-consuming, inexpensive, and safe to quantify these measurements (Subbarayalu 2016:144-145).

2.4 FORWARD HEAD POSTURE

Forward head posture is a common abnormal posture seen in patients and has been described as a position whereby the head is anteriorly displaced from a vertical reference line that passes through the lobe of the ear to the tip of the shoulder in the sagittal plane (Subbarayalu 2016:144). As the head moves forward, the centre of gravity shifts and, to compensate for this shift, the upper body shifts backwards (Subbarayalu 2016:144). This causes more strain of the neck muscles as the weight of the head is increased and this may lead to muscle imbalance (Choi 2021:3410).

Due to the advancing pace of technology, a vast majority of individuals are exposed to devices such as smartphones, computers and tablets which have become essential in modern daily living (Neupane, Ifthikar and Mathew 2017:141). In South Africa, the number of smartphone users is estimated to reach 26.3 million by the year 2023 (O'Dea 2020: para. 3, line 1). Typically, when using a smartphone, people flex their neck to look down at it and keep the head in a forward position for extended periods. This leads to strain on the neck, shoulder and upper back and has been termed "text neck," a term coined by Dr Dean Fishman (US Chiropractor) used to describe the repetitive stress or overuse injury that may occur when looking down at an electronic device (Neupane, Ali and Mathew 2017:141).

According to a study by Hoeger *et al*. (2018:319), the weight that is supported by the spine increases when flexing the head forward at various degrees, which may be attributed to the forces of gravity. An adult head typically weighs about 4.5 to 5 kilograms (kg) in the neutral position but, as the head is flexed forward, the forces placed on the neck increases to 12.25 kg at 15°, 18.14 kg at 30°, 22.23 kg at 45°, and 27.22 kg at 60° (Neupane, Ifthikar and Mathew 2017:142; Hoeger *et al*. 2018:319).

Joints commonly affected in FHP include the atlanto-occipital joint, cervical spine, temporomandibular joint, scapulothoracic joint and glenohumeral joint (Magee 2014:1017). According to Magee (2014:1017), with FHP the levator scapulae, sternocleidomastoid, scalenes, suboccipital, upper trapezius and pectoralis major and minor muscles are commonly shortened, whereas, the hyoid, lower cervical and thoracic erector spinae, middle and lower trapezius and rhomboid muscles are usually weakened; this muscle imbalance may subsequently result in upper cross syndrome, which is commonly seen in individuals with FHP, as shown in **Figure 2.6**.

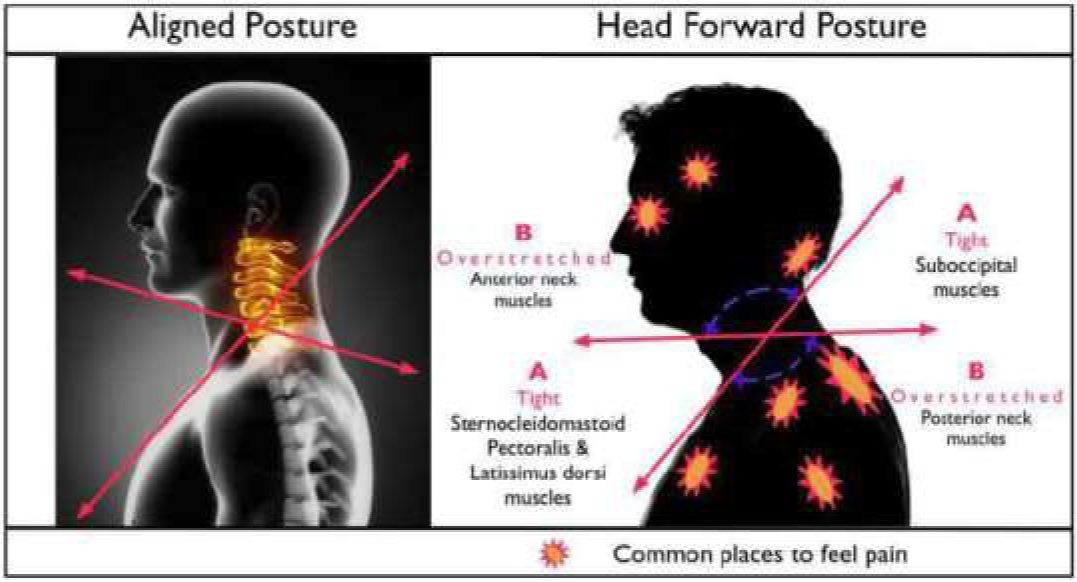

Figure 2.6: Comparison of normal aligned posture and forward head posture (Neupane, Ali and Mathew 2017:145)

2.5 PREVALENCE AND INCIDENCE

The global prevalence of FHP has been reported as high in the literature and studies have found a prevalence of around 70% among university students (Mamania and Anap 2019:125; Singh, Kaushal and Jasrotia 2020:99). Although there is a lack of literature in the South African context regarding the prevalence and incidence of FHP, the prevalence of neck pain over a 1-year period was reported as 30-50% with a point prevalence of 4.7% and is only outranked by the US, Western Europe, and East Asia (Basson 2019:1). Previous South African studies have also reported that neck pain had the highest prevalence of 50% among the Black population, which was followed by the White and the Indian population groups with a prevalence of 45% and 36.8% respectively (Ndlovu 2006:103; Slabbert 2010:5; Muchna 2011:86).

2.6 ETIOLOGY OF FORWARD HEAD POSTURE

The literature has reported multiple factors, such age, ergonomics, poor posture, mouth breathing, nutrition, pregnancy, psychological factors and trauma that may result in forward head posture. Improper posture could be improved by education, reviewing ergonomics of workstations, conservative management and managing the other etiologies associated with FHP to ensure proper posture, thereby decreasing the prevalence of musculoskeletal pain and improving the quality of life (Nejati *et al*. 2015:296).

2.6.1 Age

During the normal aging process, there is usually a decline in physiological function and changes occur in the musculoskeletal system (Elsawy and Higgins 2011:48-50). Bone density decreases, which subsequently results in degeneration of the joints, thinning of the intervertebral discs and limited movement, thus leading to a loss of muscle mass and strength, subsequently leading to changes in posture, such as FHP, increased thoracic khyphosis and reduced lumbar lordosis (Dzelchciaż and Filip 2014:836; Magee 2014:1024-1030).

2.6.2 Ergonomics and Poor Posture

Ergonomics is defined as a body of knowledge about human abilities, limitations and characteristics that are relevant to design; ergonomic design is the application of this body of knowledge to the design of tools, machines, systems, tasks, jobs, and environments for safe, comfortable and effective use for people (Stack, Ostrom and Wilhelmsen 2016:6). According to Magee (2014:1017), poor posture may result in increased loading and strain on the joints.

Maintaining poor posture may lead to mircotrauma of the joints and muscle fatigue, which may subsequently result in muscle imbalance due to the compensation of the muscles (Akodu *et al*. 2015:16-22). Examples of poor posture include forward or backward leaning of head for prolonged periods, slouched or relaxed sitting postures, sleeping with the head elevated too high and abnormal sitting posture while using a phone or computer (Akodu *et al*. 2015:16-22). The presence of muscle weakness or the lack of muscle development increases the risk for abnormal posture (Blum 2019:143-144).

2.6.3 Mouth Breathing

Mouth breathing is a mechanically incorrect form of respiration and is described as a shift from exclusively nasal breathing to mouth breathing or mixed breathing (Okuro *et al*.

2011:472). In order to facilitate the flow of air through the oral cavity, affected individuals shift the head forward and extend the neck, thus, increasing the amount of air passing through the pharynx and reducing airway resistance (Okuro *et al*. 2011:472). Various studies have assessed posture in individuals that were considered mouth breathers and FHP was found to be the most common characteristic, which subsequently leads to muscles imbalance, reduced diaphragm muscle mobility and function (Neiva, Kirkwood and Godinho 2009:227-228; Milanesi *et al*. 2011:1-6; Okuro *et al*. 2011:472).

2.6.4 Nutrition

Nutritional profiles may affect muscle development and maintenance, often associated with myofascial syndrome, and may increase the risk of altered posture (Simons, Travell and Simons 1999:186; Vizniak 2003:140-170; Bando, Murakami and Moriyasu 2020:162). Nutrition may also be linked to obesity which in turn causes a shift of the centre of gravity, resulting in altered posture to compensate for the loading on the spine (Thajer *et al*. 2020:288).

Vitamin D deficiency may result in weakening of the bone and may cause rickets (in children) and osteomalacia (in adults); it may also result in muscle weakness and increase the risk of fractures obesity (Vizniak 2003:147; Carpenter *et al*. 2017:17101).

A study by Hai *et al*. (2017:1098) found that sarcopenia (decline in muscle mass) due to aging was significantly lower in participants with normal nutritional status compared to those with a decreased nutritional status. They concluded that maintaining a good nutritional status might be effective in reducing the risk of sarcopaenia. Therefore, nutrition may play a vital role in maintaining skeletal integrity and muscle strength, and may reduce the risk of abnormal posture.

2.6.5 Pregnancy

Hormonal and physiological changes that occur in pregnancy can result in musculoskeletal complaints and the prevalence of these complaints may vary according to social or cultural background, and environmental factors (Bakilan and Zelveci 2020:53). Postural changes that occur during pregnancy are attributed to the growing uterus, which causes a shift in the centre of gravity, resulting in increased lumbar, thoracic and cervical curvatures which subsequently results in FHP (Gharib and Aglan 2018:121-123; Bakilan and Zelveci 2020:53-54).

2.6.6 Psychological Factors

The association between posture and psychological factors are limited but some studies suggest that psychological factors may possibly affect posture and are more prevalent in females (Korooshfard, Ramezanzade and Arabnarmi 2011:3698-3702; Saiiari, Khodayari and Bostani 2011:2246-2248; Park *et al*. 2015; Canales *et al*. 2017:258-264; Wilkes 2017:143-149). Depression is one such factor and symptoms include psychomotor delay, diminished energy and pain, and depressed individuals tend to have a slumped posture, slower gait, and less balance (Canales *et al*. 2017:258; Wilkes 2017:143).

Dalawala and Pimpale (2017:88-91) conducted a study in India to evaluate craniovertebral angle and depression in heavy smartphone users between the ages of 16 to 25 years (*n*=100). They found a significant prevalence of FHP and depression among smartphone users, although depression was associated more with smart phone usage than with FHP; this was consistent with the findings by Park *et al*. (2015:12-17), who conducted a similar study in asymptomatic university students in South Korea. However, the study conducted in Brazil by Canales *et al*. (2017:258-264) included participants between the age of 18 to 65 years who presented with major depressive disorder and found that the recurrence of depressive episodes may be associated with postural misalignment.

Besides depression, the presence of anxiety and self-esteem have also been found as possible factors that may contribute to poor posture (Korooshfard, Ramezanzade and Arabnarmi 2011:3698-3702; Saiiari, Khodayari and Bostani 2011:2246-2248). One of the symptoms of anxiety includes muscle weakness and tension, which may subsequently result in poor posture; additionally, associated symptoms of anxiety, such as disturbed sleep, depression and irritable bowel syndrome, may negatively impact muscle function and posture (Saiiari, Khodayari and Bostani 2011:2246-2247).

Therefore, more importance should be considered when assessing posture as it is multi factorial in causation, especially in a clinical setting, as multiple interventions are available in improving the overall wellbeing of individuals (Wilkes 2017:143-149).

2.6.7 Trauma and Accommodation to Pain

Trauma from motor vehicle accidents (MVA) and falls may result in musculoskeletal pain and discomfort, and may cause the body to alter its posture to compensate and minimise the pain experienced (Magee 2014:155-157). Holding this altered posture for a considerable amount of time may result in incorrect posture and abnormal spinal curves (Magee 2014:155-157). Whiplash is the hyperextension of the neck experienced during a rear-end MVA collision and is an example of an injury that can result in FHP (Ferrantelli *et al*. 2005:205; Moore, Dalley and Agur 2014:11).

Ferrantelli *et al*. (2005:205) investigated the treatment of a patient with chronic whiplash-associated disorders that was previously unresponsive to multiple manual therapies, but was resolved following the Clinical Biomechanics of Posture rehabilitation methods. This method is a conservative approach to patient rehabilitation and entails translation and rotation exercises, that can be coupled together with spinal adjustments and traction to restore normal posture (Ferrantelli *et al*. 2005:205). They found that reducing forward head posture improved range of motion and significantly reduced pain, thus, emphasising the need to address and treat postural abnormalities with conservative care.

2.7 POSSIBLE IMPLICATIONS OF FORWARD HEAD POSTURE

The literature has found various possible associations and impacts that FHP may have on affected individuals' lives. This section will include some of the implications of FHP, such as neck pain, headaches, temporomandibular disorders, cervical radiculopathy, blood pressure, respiratory dysfunction, and dysphagia.

2.7.1 Association of Forward Head Posture and Neck Pain

Neck pain is a common disorder characterised by "pain, discomfort or soreness experienced in a region between the inferior margin of the occipital bone and T1" (Nejati *et al*. 2015:295). Neck pain is considered as one of the most debilitating musculoskeletal complaints affecting individuals and has been estimated to rank twentieth in the burden of disease for South Africa (Basson 2019:1). Addressing factors associated with neck pain will help reduce the onset and intensity of work-related neck pain and its associated absenteeism (Louw *et al*. 2017:a329). The apparent association between awkward postures and the development of musculoskeletal disorders indicates the need for measuring neck posture and movement in occupational settings to allow for these factors to be assessed (Carnaz, Batistao, and Coury 2010:10967; Basson 2019:1).

A study by Akodu *et al*. (2015:14) investigated the prevalence of work-related musculoskeletal disorders among secretaries in a state public service in Nigeria and their associations with working posture. They utilised a cross-sectional survey among 150 participants and working posture was assessed by measuring any variation in CVA. They found that the prevalence of low back pain was the highest (71.3%), followed by neck pain (59.3%), shoulder pain (48.0%) and hand pain (28.0%). The results of their study showed a significant decrease in CVA scores between participants with neck pain and those without neck pain. This indicates that poor posture is a high risk factor for the prevalence of neck related musculoskeletal disorders among computer users.

Mahmoud *et al*. (2019:562-577) conducted a systematic review on observational studies conducted from 2009 to April 2017 to analyse the relationship between FHP and neck pain. Their results found that adults with neck pain showed an increase of FHP when compared to asymptomatic adults and that FHP was significantly correlated with neck pain measure in adults. These findings emphasise the need to have a normal range as a guideline for clinicians to address FHP, as musculoskeletal complaints are the most common reasons reported for work-related illness, long-term sick leave and disability which results in an economic burden (Nejati *et al*. 2015:296).

2.7.2 Association of Forward Head Posture and Headaches

Headaches are one of the most commonly reported multifactorial complaints seen by healthcare physicians and is defined as a pain occurring in the head and neck (Tali *et al*. 2014: 570; Choi 2021:3411). Headaches are divided into primary and secondary headaches (Elizagaray-Garcia *et al*. 2020:2465). Primary headaches are considered to have no specific cause and according to the International Classification of Headache Disorders, third edition (ICHD-3), primary headaches include migraine, tension-type headache and trigeminal autonomic cephalagias (Tali *et al*. 2014: 570; Elizagaray-Garcia *et al*. 2020:2465). In contrast, secondary headaches occur in the presence of an underlying cause, such as trauma or illness, and tend to be serious in comparison to primary headaches (Elizagaray-Garcia *et al*. 2020:2465).

Multiple studies have associated FHP with headaches and attributed it to the muscle imbalance that occurs (Fernández-de-las-Peñas *et al*. 2005:314; Tali *et al*. 2014: 570; Elizagaray-Garcia *et al*. 2020:2465; Choi 2021:3410-3411). A study conducted by Fernández-de-las-Peñas *et al*. (2005:314) compared FHP and neck mobility in participants who presented with chronic tension-type headache (*n*=25) and in asymptomatic participants (*n*=25); they noted that the participants who presented with chronic tension-type headaches had smaller CVA and range of motion than the asymptomatic group. These findings are consistent with the studies by Duani (2010:43-63) and Tali *et al*. (2014: 572-573).

Elizagaray-Garcia *et al*. (2020:2465) conducted a meta-analysis to summarise the characteristics in the cervical region found in subjects with chronic primary headaches in comparison to those with episodic primary headaches and the asymptomatic population. They concluded that there was moderate to strong evidence that those with chronic primary headaches present with greater FHP than the asymptomatic population, and moderate evidence that FHP is greater in those with chronic primary headaches when compared to those with episodic primary headaches.

Therefore, in order to properly address headaches that are associated with FHP, further research needs to be done to adequately diagnose and manage FHP to reduce its implications on individuals and the economy.

2.7.3 Association of Forward Head Posture with Temporomandibular Disorder

The temporomandibular joint (TMJ) is a synovial, bicondylar articulation that connects the mandible to the skull. Temporomandibular disorders (TMD) are defined as neuromuscular and musculoskeletal conditions that arise due to problems experienced with the TMJ, masticatory muscles and associated structures (Magee 2014:224-226; Dağ, Demirel and Özalp 2018:104). With FHP, the hyperextension of the neck leads to shortening of the sub-occipital and elongation of hyoid muscles, resulting in elevation of the hyoid bone, thus causing the mandible to be directed in an elevated and retruded position, subsequently resulting in a reduced interocclusal space (Augustine *et al*. 2008:137-138; Magee 2014:224-226). Although there are studies which have found an association between FHP and TMD, some research fails to prove that a significant association may exist (Augustine *et al*. 2008:136-143; Faulin *et al*. 2015:1-6; Dağ, Demirel and Özalp 2018:104-109).

2.7.4 Association of Forward Head Posture and Cervical Radiculopathy

According to Harrison *et al*. (1999:227-234), all spinal postures may deform the neural elements within the spinal canal and neural tissue strains are dependent on the spinal level, movement, and the sequence of movements when more than one spinal area is moved (Harrison *et al*. 1999:227-234). Therefore, FHP may affect the functioning of the cervical nerves (Celik *et al*. 2020:622). Celik *et al*. (2020:621-628) conducted a study to evaluate neurodynamic tests and peripheral nerve conductions of the upper extremity in individuals that presented with FHP; they concluded that FHP makes individuals more susceptible to nerve entrapments than those without FHP.

A study by Diab and Moustafa (2011:351-361) investigated the effect of forward head posture on pain and nerve root function in patients with cervical spondylotic radiculopathy. They included participants (*n*=96) who presented with lower cervical spondylotic radiculopathy and a CVA of less or equal to 50; the control group (*n*=48) received ultrasound and infrared radiation, whereas the experimental group received a posture corrective exercises in addition to ultrasound and infrared radiation. They found that the experimental group had reduced pain and improved nerve root function more than the control group and concluded that reducing FHP was effective in reducing pain and improving the nerve root function in cases of cervical spondylotic radiculopathy. These findings are similar with the findings of the study conducted by Wickstrom, Oakley and Harrison (2017:1472-1474). Therefore, addressing FHP in cases of cervical radiculopathy may prove to be beneficial in a clinical setting.

2.7.5 Effect of Forward Head Posture on Blood Pressure

According to Kadu, Shetye and Mehta (2019:98-103), the cervical spine is in close proximity to neurovascular structures and, therefore, misalignment of the cervical spine may lead to altered blood pressure (BP). They conducted a study to compare peripheral arterial BP in individuals with and without FHP. They had a group with FHP (*n*=64) and a group without FHP (*n*=64). They took BP readings in a seated position over the brachial artery and one digital image was taken in lateral view used for measuring CVA. They compared CVA, systolic blood pressure (SBP), and diastolic blood pressure (DBP) of the two groups. They found SBP and DBP of both the groups were within the normal range, which was expected because the subjects were young students with no clinical symptoms, but the mean SBP was significantly higher in subjects with FHP than in subjects without FHP. They concluded that peripheral arterial BP in individuals with FHP is statistically significantly higher than in individuals without FHP. However, the evidence to support this is limited and further research may be required to associate elevated BP with FHP.

2.7.6 Effect of Forward Head Posture on Respiratory System

FHP is thought to affect respiratory function by weakening the respiratory muscles (Han *et al*. 2016:128-131; Koseki *et al*. 2019:63-68). FHP leads to accessory muscle recruitment, with increased sternocleidomastoid muscle activity, causing rib cage elevation and, thus, reducing thoracoabdominal mobility, and compromising the ventilatory efficacy of the diaphragm, and, subsequently, resulting in increased inspiratory and breathing effort (Kim, Kim and Kim 2016:1851-1854; Kim, Cha and Choi 2017:711-715: Solakoğlu, Yalçın and Dinçer 2020:161-168).

Inefficient respiratory muscle function decreases respiratory muscle strength, resulting in reduced chest expansion, which impairs pulmonary ventilation during physical activity (Kim, Kim and Kim 2016:1851-1854; Kim, Cha and Choi 2017:711-715: Solakoğlu, Yalçın and Dinçer 2020:161-168).

Solakoğlu, Yalçın and Dinçer (2020:161-168) investigated the relationship between FHP and respiratory dysfunctions in patients with chronic neck pain; they concluded that FHP may be associated with expiratory muscles weakness in chronic neck pain patients. These findings are similar to those of Han *et al*. (2016:128-131) and Koseki *et al*. (2019:63-68).

A study by Jung *et al*. (2016:186-189) investigated the changes in posture and respiratory functions depending on the duration of smartphone usage. Participants were randomly allocated to two groups: participants who used smartphones for less than four hours per day (*n*=25) and participants who used smartphone for more than four hours per day (*n*=25). Significant differences were found in CVA, scapular index, and peak expiratory flow depending on the duration of smartphone usage. The group that used smartphones for more than four hours per day were found to have had a reduced CVA and reduced respiratory function than those who used a smartphone less than four hours per day; they concluded that prolonged use of smartphones could negatively affect both posture and respiratory function. Therefore, these findings suggest that correcting FHP may improve respiratory function.

2.7.7 Effect of Forward Head Posture on Swallowing

According to Papadopoulou *et al*. (2013:469-480), swallowing dysfunction (dysphagia) may be related to postural changes associated with the cervical spine. Mathur, Khan and Siddiqui (2019:97-100) reviewed the literature to determine the effect of forward head posture on swallowing. They reviewed studies that used video fluoroscopy and endoscopy to objectively measure swallowing and concluded that chronic forward head posture affects the efficiency of swallowing negatively. They attributed this to postural changes in the neck causing compensatory changes in the kinesiology chain, leading to tightness of one group and weakness of other groups of muscles which affect the visceral physiological function of swallowing.

A study conducted by Jeon, Cho and Park (2020:478-488) investigated the therapeutic effects of neuromuscular electrical stimulation combined with upper cervical spine mobilisation in stroke patients with dysphagia, and found a significant improvement in FHP and swallowing function in the experimental. These findings suggest that FHP may affect swallowing; therefore, it is imperative for FHP to be adequately assessed and treated, as it may improve swallowing function in patients with dysphagia.

2.8 TREATMENT OF FORWARD HEAD POSTURE

Medical treatment for FHP is targeted more at pain relief, rather than correction of FHP. Therefore, primary treatment considered for FHP is manual therapy and includes spinal manipulative therapy and mobilisation, exercise, interferential current therapy, myofascial trigger point release techniques and kinesiology taping. Identifying poor posture and educating patients on proper ergonomics would also prove to be beneficial in a clinical setting.

2.8.1 Allopathic Intervention

Surgery is not indicated for musculoskeletal related spinal pain, unless it caused by severe degeneration, fracture or tumour (Filler 2013:183-184,213; McLatchie, Borley and Chikwe 2013:554-555,578). Over-the-counter pain medications are typically used for pain relief, with prescription-strength medications given, should the over-the-counter pain medication prove to be ineffective (Neupane, Ifthikar and Mathew 2017:146). However, each medication comes with potential risks and benefits and usage of this intervention should be minimised as dependency, addiction and possible complications may prove to be less beneficial in chronic pain management (Neupane, Ifthikar and Mathew 2017:146).

Cervical epidural steroid injections involve injecting a cortisone steroid into the cervical epidural space, which is the outer layer of the spinal canal, and aim to reduce inflammation of the nerves and adjacent structures (Neupane, Ifthikar and Mathew 2017). Similarly, cervical facet injections also involve injecting steroids into a specific joint. However, both interventions aim to reduce pain which is usually temporary, and it carries the risk of causing infection (Neupane, Ifthikar and Mathew 2017:146; Filler 2013:174).

Trigger point injections involve injecting saline, cortisone, dextrose or lidocaine at specific irritation spots within muscle bundles that may be the source of pain, and these injections may be effective for trigger point irritations to the neck muscles; however, they may not have a long term efficacy (Neupane, Ifthikar and Mathew 2017:146).

2.8.2 Conservative Intervention

Spinal manipulation therapy (SMT) is a specific 'hands-on' clinical approach used by a variety of health practitioners, such as chiropractors, to treat musculoskeletal pain (Sampath *et al*. 2015:819). A chiropractic adjustment is a specific form of joint manipulation that is characterised by a low amplitude, high velocity thrust (Bergman and Peterson 2011:84-90). A study conducted by du Plessis (2010:48-66), in the greater area of Johannesburg, investigated the effect of cervical spinal manipulative therapy on FHP. The study included 30 participants who presented with FHP on general screening and each participant underwent an eight-week trial in which cervical spinal manipulative therapy was administered. Craniovertebral angle was measured using a lateral radiograph pre- and post-intervention. The study revealed a mean decrease of 2.23° post-intervention, which indicates that cervical spinal manipulative therapy can have a beneficial effect in reducing FHP. These findings are consistent with those of Morningstar, Strauchman and Weeks (2003:51-54); Gong (2015:1609-1611); Wickstrom, Oakley and Harrison (2017:1472-1474); and Fathollahnejad, Letafatkar and Hadadnezhad (2019:86-94). Therefore, SMT may be an effective intervention for FHP.

Myofascial release technique is a form of manual therapy that causes the release of the chain between fascia, muscle, and bones to stretch the fascia (Simons, Travell and Simons 1999a:278-328, 143; Aggarwal, Shete, Palekar 2018:149-155).

A study conducted by Aggarwal, Shete and Palekar (2018:149-155) investigated the efficacy of suboccipital release and sternocleidomastoid release technique in FHP patients with neck pain. They conducted a randomised control trial that included 60 participants divided into an experimental group (*n*=30) and control group (*n*=30); the experimental group received suboccipital and sternocleidomastoid myofascial release and the control group received resisted chin tucks. They found that myofascial release technique for suboccipital and sternocleidomastoid muscles were more effective using conventional therapy in improving FHP and reducing neck pain. These findings are consistent with the findings of Kim *et al*. (2016:31-37) and Miranda and Kage (2020:113-115).

Multiple studies have found that stretches and muscle strengthening exercises targeting the muscles involved in FHP are effective in increasing CVA, thus improving FHP (Kim *et al*. 2016:31-37; Sheikhoseini *et al*. 2018:531-539: Parwaria *et al*. 2019:70-74; Sikka *et al*. 2020:1-7 Choi 2021:3410-3421; Dhinju, Paulraj and Harithra 2021:97-104). Additionally, corrective exercises applied to the cervical spine and upper thoracic region have shown improvement in range of motion, neck disability and pain that may be associated with FHP (Sheikhoseini *et al*. 2018:531-539).

A study conducted by Choi (2021:3410-3421) investigated the effect of flexion exercises of the deep cervical muscles on FHP, tension headaches and sleep disorders. The study included 32 participants divided into the experimental group (*n*=16), who performed deep cervical flexion exercises, and the control group (*n*=16), who were given stretches to perform. Their results indicated that flexion exercises of the deep cervical muscles were more effective in improving FHP, sleep, and tension headaches, which was attributed to the increase in spinal stability, reduced muscle tension, and increased muscle strength, as compared to stretching, which temporarily improved posture by elongating shortened muscles. These findings were like those of Sikka *et al*. (2020:1-7) and Dhinju, Paulraj and Harithra (2021:97-104).

Interferential current (IFC) is a modality that uses low frequency electrical stimulation indicated for muscle relaxation and pain relief (Choi *et al*. 2018:398-399). A study conducted in South Korea by Choi *et al*. (2018:398-399) investigated the effect of IFC on shoulder muscles of participants who presented with FHP; they included 30 participants who were divided into an experimental group (*n*=15) and control group (*n*=15). The experimental group was treated with IFC for 10 minutes, three times per week, for three weeks, over the trapezius and levator scapular muscles; they found a significant improvement of FHP and structural alignment. These findings are similar to the studies by Acedo *et al*. (2015 28: 19–24) and Song, Choi and Cha (2019:15-23). Therefore, IFC may prove to be an effective treatment modality to improve FHP that is non-invasive and accessible to manual therapists.

Kinesio taping (KT) is a form of elastic therapeutic tape that is becoming an increasingly popular modality used indicated for musculoskeletal pain in clinical practice; it is hypothesised to work by improving blood circulation, reducing local oedema, and providing stimulus and support to the targeted muscles and surrounding structures (Öztürk *et al* 2016: 1074-1075; Shih *et al*. 2017:725-726).

Shih *et al*. (2017:725-733) conducted a study in Taiwan to investigate the effects of Kinesio taping and exercise on FHP. They included 60 participants who were assigned into three groups: an exercise group (*n*=20), taping group (*n*=20) and control group (*n*=20). They found that both the exercise and taping group showed significant improvements in FHP when compared to the control group. This indicates that Kinesio taping and exercise may be effective modalities in the treatment of FHP.

2.9 FORWARD HEAD POSTURE AND NECK PAIN IN THE SOUTH AFRICAN CONTEXT

In South Africa, although no studies on the prevalence of FHP and neck pain were found to have been done, neck pain alone was reported to be highest among the Black population (50%), followed by the White (45%) and Indian (36.8%) populations in the greater Durban area (Ndlovu 2006:103; Slabbert 2010:5; Muchna 2011:86).

Kamerman *et al*. (2020:1629-1635) conducted a survey in South Africa to investigate the prevalence of chronic pain in South Africa. The study included 10 336 participants in total from the nine provinces and found that almost one in every five South African adults had chronic pain and that it was 20% greater in South African women than it was in men. These findings are consistent with the findings of Lee *et al*. (2018: 859-860). This indicates that there is a high prevalence for chronic pain in South Africa, which emphasises the need to address associated risk factors and interventions for chronic pain.

Roopnarian (2011:29-42) and Naicker (2013:32-44) investigated normal cervical spine parameters on radiographs in males and females within the Black, White, Indian and Coloured populations in KwaZulu-Natal in South Africa. Roopnarian (2011:4-5) reported that significant differences were observed in males among the four ethnic groups in the mean sagittal canal diameter and interpedicular distance, whereas Naicker (2013:5-7) reported no significant differences in the mean sagittal canal diameter and interpedicular distance among females of the four ethnic groups but noted a significant difference in cervical lordosis, with Black South African females having a significantly higher cervical lordosis than White and Indian females. This indicates that normal cervical parameters differ among various ethnic groups and gender.

It is estimated that about two-thirds of the population in sub-Saharan Africa must leave their homes to collect water which puts them at a high risk of musculoskeletal complaints (Graham, Hirai and Kim 2016:1-2). Geere, Hunter and Jagals (2010:1-13) conducted a study to observe and identify domestic water carrying and its implications for health in the province of Limpopo in South Africa, and found that water carrying was mainly performed by women or children carrying containers on their head with a mean weight of 19.5 kg over a mean distance of 337 m. They also found that the prevalence of spinal pain was 69%. This may indicate that women living in rural parts of South Africa, particularly Black South African women, are more susceptible to developing musculoskeletal complaints from carrying heavy load over their heads.

2.10 GLOBAL AND SOUTH AFRICAN OBSERVATIONAL STUDIES ON CVA

The severity of FHP has been rated by therapists as minimal, moderate or maximal without any objective numeric values and so the perception of an “ideal” posture is based on clinical judgment, which may be considered a potential source of error (Yip, Chiu and Poon 2008:151). The smaller the CVA, the greater the FHP and the greater the FHP, the greater the disability (Yip, Chiu and Poon 2008:151; Kim, Kim and Son 2018:309-313; Lee *et al*. 2018: 859-860). Visual assessments and lateral radiographs were previously used to measure FHP and CVA (Subbarayalu 2016:144-145). Given the advances in technology, lateral photographs and computer software have been developed, thereby making it more reliable to quantify these measurements (Subbarayalu 2016:144-145).

A study conducted in Hong Kong by Yip, Chiu and Poon (2008:151-152) investigated the relationship between head posture with pain and disability in patients with neck pain. Participants with neck pain (*n*=62) and those without neck pain (*n*=52) were recruited by convenience sampling. The craniovertebral angle was measured using the head posture spinal curvature instrument and they reported that FHP may be associated with neck pain and revealed that the mean average of CVA in participants with neck pain was 49.93° as opposed to the mean average of 55.02° in participants without neck pain. Studies by Diab and Moustafa (2011:352), Ruivo, Pezarat-Correia and Carita (2014:365) and Camitsis (2015:42-47) used 50.00° as a reference angle based on the findings of the study by Yip, Chiu and Poon (2008:152), which further emphasises the need for further studies to be conducted that utilise more advanced methods, such as digital photography and computer software, in order to obtain more reliable measurements.

A study conducted in South Korea by Kim, Kim and Son (2018:309-313) investigated whether CVA and the cervical range of motion (ROM) was different between participants with a FHP, with or without pain. They included 44 participants who had FHP and assessed FHP using digital photography by measuring the angle between the horizontal line passing through the neural spine of C7 and the line connecting the tragus of the ear and the neural spine of C7 on the lateral view for each subject. The participants were allocated to either with pain (*n*=22), or without pain (*n*=22) groups. The mean average of CVA in the pain group 44.44° and the mean average in the pain free group was 48.63°, which is similar to the study done by Yip, Chiu and Poon (2008:151-152) that found that decreased CVA was a predictive factor for the occurrence of pain in the cervical region.

Salahzadeh *et al*. (2014:131-139) conducted an observational study to compare CVA, head tilt angle and head position angle to differentiate and measure FHP. The study included 78 female participants in Iran and was classified into groups of non-FHP, slight FHP and moderate to severe FHP. Significant differences were only noted for CVA measurements among the three groups, which indicate that CVA is the most reliable measurement that can accurately assess FHP. The mean CVA in the non-FHP group was 55.00°, which is consistent with the study by Yip, Chiu and Poon (2008:151-152). However, various other studies have reported CVA measurements in asymptomatic participants that ranged from 34° to 62° (Brink *et al*. 2009:652; Kim and Kim 2016:2930; Subbarayalu 2016:149). These inconsistent findings further emphasise the need to conduct studies that take homogeneity of the study sample into account.

Brink *et al*. (2009:647-649) conducted a study to assess the association between postural alignment and upper quadrant pain in high school students (*n*=94) from six randomly selected schools in the province of Western Cape in South Africa. They measured CVA using digital photography on seated participants working on computers and measured upper quadrant pain using a questionnaire. They concluded that having decreased CVA may contribute to upper quadrant pain in high school students using desktop computers. The mean average of CVA they obtained was 39.27° (ranging from 18.80° to 59.10°).

A study conducted by Camitsis (2015:42-47), in the greater Durban area, investigated the effect of craniocervical flexion exercises on cervical posture which was done by measuring the CVA of asymptomatic participants (*n*=45) before and after the intervention and reported a significant increase in CVA measurements after the intervention, as opposed to the control group which did not reveal a significant increase. Measurements were taken in both seated and standing positions to improve accuracy. The overall seated CVA was 39.50° before the intervention and 44.80° after the intervention and the overall standing CVA was 43.10° before the intervention and 48.80° after the intervention. This indicates that craniocervical flexion exercises can be utilised as an effective treatment intervention for FHP; however, a standardised and normalised range for CVA is needed, to better enable a set reference point for clinical practice and research as there has not yet been a generally accepted reference point.

2.11 CONCLUSION

Considering the advancing pace of technology, the exposure and usage of smartphones, computers and other hand-held devices are set to increase. According to O'Dea (2020), about 20 to 22 million individuals use smartphones in South Africa, which accounts for about one third of the population and this figure is estimated to increase by more than five million by the year 2023. This may increase the incidence of FHP and subsequently may result in postural-related musculoskeletal pain, increased peripheral blood pressure, dysphagia and impaired respiratory function (Akodu *et al*. 2015:16; Jung *et al*. 2016:186; Kim and Kim 2016:2929; Kadu, Shetye and Mehta 2019:98; Mathur, Khan and Siddiqui 2019:97). Therefore, it would be beneficial to have a normal CVA range for chiropractors and other physicians to enable them better to identify and quantify FHP, as studies have reported various treatments such as spinal manipulative therapy and mobilisation, interferential current therapy, myofascial trigger point release techniques, kinesio taping and exercise increase CVA, thus correcting or improving FHP to manage or prevent the negative impacts associated with FHP (Morningstar, Strauchman and Weeks 2003:51; du Plessis 2010:48-66; Camitsis 2015:42-47; Gong 2015:1611; Kim *et al.* 2016:31 and Choi *et al.* 2018:398).

Having a normal CVA range will also aid clinicians in determining the effectiveness of treatment modalities and to assess patient prognosis.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

In this chapter, the research design, study location, study population, sampling strategy, measurement tools, research procedure, data reduction, analysis, and ethical considerations will be discussed.

3.2 STUDY DESIGN

A pilot study was conducted using a quantitative, non-experimental, observational design. A pilot study is conducted on a smaller scale than the main or full-scale study and is important for improvement of the quality and efficiency of the full-scale study, as well as providing estimates for sample size calculation (In 2017:601). This is ideal for this study due to the paucity in the literature, particularly in a South African context, as this pilot study would determine the feasibility for full-scale studies and aid in providing estimates for adequate sample sizes for future studies.

According to Park, Konge and Artino (2020:690-691), research paradigms guide scientific discoveries through their assumptions and principles. The positivist paradigm is based on the assumption that a single tangible reality exists that can be understood, identified and measured (Park, Konge and Artino 2020:690-691). Thus, this study fits within the positivist paradigm as the study is an observational study aimed at measuring biomechanical measurements that result in objective findings.

According to Jhangiani *et al*. (2019:394), quantitative research typically starts with a focused research question or hypothesis, collects a small amount of numerical data from a large number of individuals, describes the resulting data using statistical techniques, and draws general conclusions about some large population. Non-experimental research designs embody a group of techniques used to conduct quantitative research where there is no manipulation or interference done to any of the variables in the study and an observational design focuses on making observations based on behaviour in a natural or laboratory setting without manipulating anything (Jhangiani *et al*. 2019:46-49). This design is ideal for this study as only biomechanical measurements were observed and recorded and no treatment was administered to change any variables.

This study was approved by the Institutional Research Ethics Committee (IREC) of the Durban University of Technology (Appendix A).

3.3 STUDY LOCATION

Data collection was carried out at the Durban University of Technology (DUT) Chiropractic Day Clinic (CDC) (Appendices B and C).

3.4 STUDY POPULATION

According to Lee *et al*. (2018: 859-860), females are more at risk to having postural-related musculoskeletal complaints. Black South Africans have the highest prevalence of neck pain and comprise of an estimated 80.7% of the population (Ndlovu 2006:103; Slabbert 2010:5; Muchna 2011:86; Statistics South Africa 2019:8). As normal cervical spine radiographic parameters were reported to differ among the various ethnic groups in South Africa (Roopnarian 2011:29-42; Naicker 2013:32-44), normal CVA ranges in Black South African women may also differ. Thus, Black South African females residing in the eThekwini Municipality, KwaZulu-Natal were included in this study, which also allowed for homogeneity of the population sample.

3.5 SAMPLING STRATEGY

3.5.1 Sample Recruitment

Participants were recruited from the eThekwini Municipality via advertisements (Appendix D). These advertisements were placed in the local newspapers of the surrounding communities, within the DUT campuses, stores, and libraries in the greater Durban area. Prospective participants were also recruited by word of mouth. Prospective participants who contacted the researcher underwent a telephonic screening to determine their eligibility to participate in the study. If the participant was considered eligible to participate in the study, an appointment was scheduled at the DUT CDC.

Table 3.1: Telephonic screening questions and expected answers

Questions for prospective participants	**Expected answers**
Please may I ask you some questions?	Yes
Are you between the ages of 18 and 45 years?	Yes
Which of the following best represents your ethnicity? Black African; White; Coloured; Indian/Asian; Other	Black African
Do you currently have neck pain?	No
Do you have a history of neck pain in the last three months?	No
Is there any chance that you are pregnant?	No
Have you had any surgery to the neck?	No

3.5.2 Sample Size and Allocation

According to Connelly (2008:411-412), it is recommended that a pilot study sample be a proportion of the sample projected for the full-scale study; however, they may be larger depending on the aim of the full-scale study. The sample size projected for a full-scale study is 385, which was calculated by a statistician (Mr F Kaseke), using a Cochran formula with a 95% confidence level and a 5% margin of error. Therefore, a sample size of 51 Black South African females was included in this pilot study.

3.5.3 Inclusion and Exclusion Criteria

Inclusion Criteria:

- All participants were between the ages of 18 and 45 years. The lower age limit was necessary to avoid including participants who could not give consent of their own free will and the upper age limit was necessary to avoid age-related degeneration.

- All participants were of female gender. This was done to maintain sample homogeneity with respect to gender as studies have reported differences in normal radiographic parameters of the cervical spine among males and females.
- Participants were to be South Africans of Black African ethnicity. This was to maintain sample homogeneity with respect to ethnicity and the high prevalence of neck pain in Black South African females.
- Participants who did not present with FHP on observational assessment. The ear must be aligned to the tip of the shoulder. If the shoulder has a forward position the middle trunk should be used as a reference for detecting FHP.
- Participants are to be free of neck pain and/or cervicogenic headaches for the last three months.

Exclusion Criteria:

- Participants who had a history of cervical trauma, cervical fracture, cervical spine surgery, rheumatoid arthritis, and congenital musculoskeletal abnormalities.
- Participants who were pregnant.
- Participants who did not give consent to participate in the study.

3.6 MEASUREMENT TOOLS

A Canon digital camera was used to take a photograph of the lateral view of each participant to objectively assess FHP. The Posture Pro Software Analysis (developed by Ventura Design©) was utilised to measure the degree between the tragus of the ear and C7 spinous process landmarks to objectively measure CVA. Photogrammetry is the use of photographs in mapping and surveying to obtain measurements between points and objects which has shown to be viable, valid, and reproducible when evaluating the spine. In addition, the Posture Pro Software Analysis has shown good to excellent intra-rater reliability and fair to excellent inter-rater reliability for most measurements (Senthil *et al*. 2017:3; Hébert-Losier and Rahman. 2018:483).

3.7 RESEARCH PROCEDURE

Prospective participants were screened telephonically (Appendix E) with information regarding ethnical background, gender, age and must be asymptomatic. Upon arrival at the DUT CDC, prospective participants were required to be screened for any symptoms of COVID-19, their hands were sanitised and a temperature reading was also be taken. Contact details were recorded should contact tracing be required. Both the researcher and the participant were required to wear masks throughout the duration of the research procedure, but participants were requested to remove their masks if it obscured the marker that was placed at the tragus of the ear when measuring CVA. In such instances, the researcher maintained a distance of 1.8 m from the participant (Chu *et al*. 2020:1979). The participants were then given a letter of information (Appendices F1 and F2) and a consent form to read and sign (Appendices G1 and G2). The researcher verbally explained the nature of the study fully. Prospective participants were also given an opportunity to ask any questions pertaining to the study. Participants were only allowed to proceed with the study provided they had met all the inclusion criteria.

The height and weight of the participants were taken. The tripod was marked on the floor to prevent any displacement to ensure consistency between measurements. Thereafter, colourful labels were placed at the tragus of the ear and at the C7 spinous process to mark the landmarks to measure CVA. The C7 spinous process was located by asking the participant to move the neck into flexion and extension; with this motion, the C6 spinous process disappears on extension, the C7 spinous process has some motion but is palpable and the T1 spinous process is fixed (Salahzadeh *et al*. 2014:133).

Figure 3.1: Lateral photograph of a participant in seated position using Posture Pro software analysis

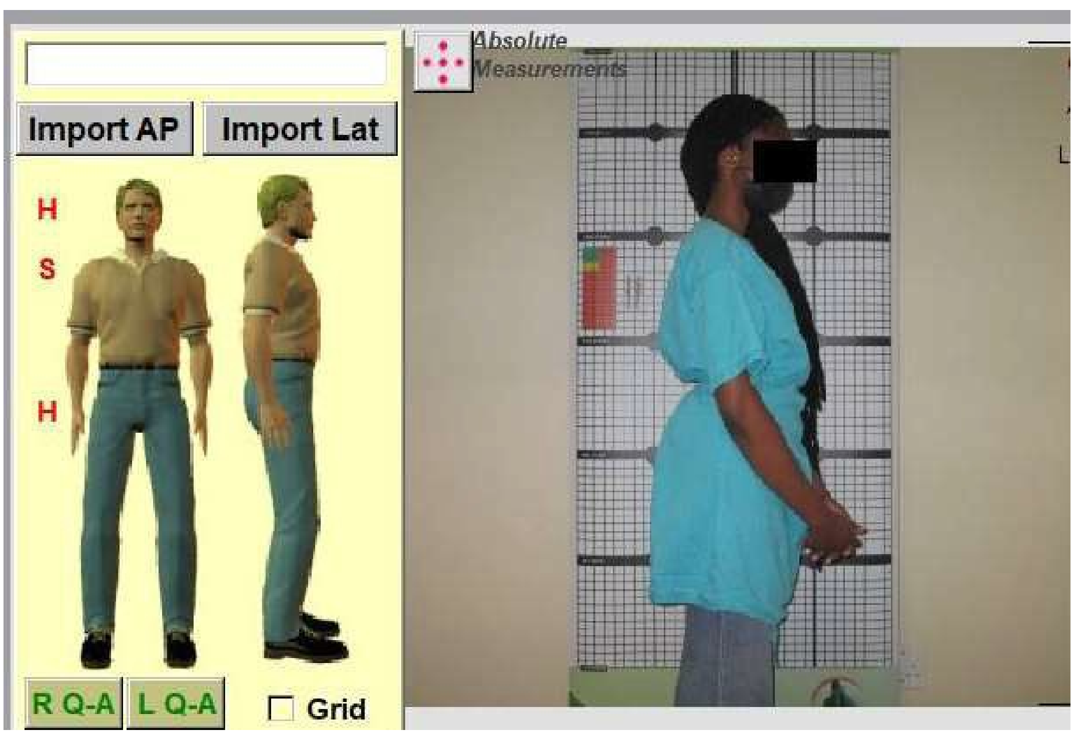

Figure 3.2: Lateral photograph of a participant in standing position using Posture Pro software analysis

Once markers had been placed, participants were positioned at a marker 1.8 m away from the digital camera and a photograph of the lateral view was taken with the participant in seated (**Figure 3.1**) and standing (**Figure 3.2**) positions. All equipment used was disinfected both before and after use, as well as any surfaces that the researcher or the participant had touched.

The Posture Pro Software Analysis (developed by Ventura Design©) was used to measure CVA in standing and seated positions, as previous studies have looked at both positions as the normal standard as measurements differ depending on the position due to changes in the spinal curvatures. This improved the accuracy of the measurements (Camitsis 2015:32, 42-47; Fard *et al*. 2016:3577-3578; Kim and Kim 2016:2929-2932).

3.8 DATA REDUCTION AND ANALYSIS

Data were captured on Microsoft Excel and transferred to the latest version of Statistical Package for the Social Sciences (SPSS; version 27.0; release 2020) and statistically analysed. Descriptive statistics were used to determine means and standard deviations. Data were summarised using a contingency table. Inferential statistics were used to measure the normal CVA range among asymptomatic Black South African females.

3.9 ETHICAL CONSIDERATIONS

Autonomy is when people have the right and capacity to make their own decisions about medical procedures, treatment and biomedical research (Manda-Taylor, Masiye and Mfutso-Bengo 2015:1). The researcher recognising and respecting the participant's decision to take part in the study accounted for this. All participants were required to read a letter of information (Appendices F1 and F2) and sign a consent form to participate in the study (Appendices G1 and G2)

The participants were Black South African females. Confidentiality and identification of participants were maintained by using coded data collection sheets.

Non-maleficence expresses the potential risks of participation. It emphasises what constitutes harm, which could be physiological, emotional, social or even economic in nature (Akaranga and Makau 2016:6-7), which was accounted for as the rights and welfare of the participants were protected as no intentional harm had come to them. Participants were not coerced or unduly influenced into participating in the study. Participation was voluntary and did not involve financial benefits.

Beneficence refers to “doing good” and “be of benefit, do not harm” (Akaranga and Makau 2016:6-7), and this was accounted for as the results of this study could affect how FHP is treated and therefore benefit the health care professionals and their patients.

3.10 CONCLUSION

Therefore, the method used in this study was photogrammetry using a digital camera which was then assessed using the Posture Pro software analysis to obtain the angles measured between the tragus of the ear and C7 spinous process. The digital images were used to determine the linear coordinates of each landmark and this was used to compare the postural measurements of each participant. This method has shown to be simpler and less expensive when compared to previous radiographic methods to obtain measurements which also add the risk of exposing the participants to radiation (Reddy 2015:39; Senthil *et al*. 2017:3; Hébert-Losier and Rahman. 2018:483).

This chapter conveyed all aspects involving the methodology of the study. The next chapter will present the results of the study.

CHAPTER 4

RESULTS

4.1 INTRODUCTION

In this chapter, the research findings of the study obtained will be reported in the form of tables and graphs. Of the 54 individuals that responded to participate in the study, three participants did not meet the inclusion criteria; therefore, 51 participants were included in the study.

4.2 OBJECTIVE OUTCOMES

This section begins with an overview of the demographic profiles and selected anthropometric characteristics of the participants, which include age, occupation height, weight, BMI and craniovetebral angle. It is followed by the findings of the inferential analysis and factor analysis employed in this study.

4.2.1 Age

As shown in **Table 4.1** and **Figure 4.1**, over three quarters (78.4%) of the respondents were aged between 20 to 29 years; 15.7% were below 20 years while 5.9% were above 30 years. The average age of the participants was 22.5 years, with the youngest participant being 18 years old and the oldest being 41 years old.

Table 4.1: Age variable of sample population

Demography variable	Category	Frequency	Percentage
	Below 20	8	15.7%
Age group	20-29	40	78.4%
	Above 30	3	5.9%

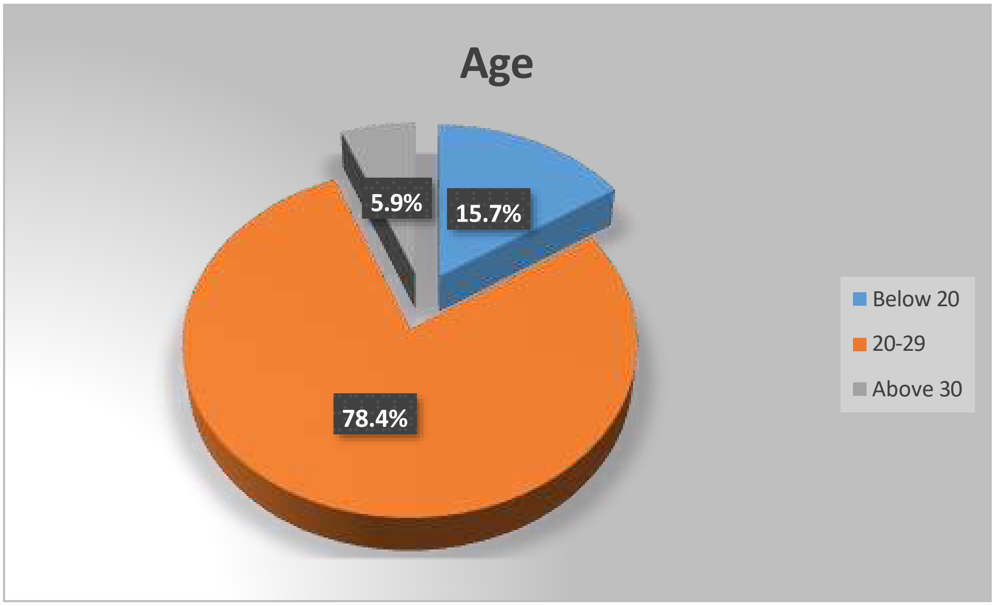

Figure 4.1: Age distribution

4.2.2 Occupation

The sample was predominantly made of students who constituted 94%. The others were a hairdresser, homemaker and receptionist with 2% each, which is shown in **Table 4.2** and **Figure 4.2**.

Table 4.2: Occupation variable of sample population

Demography variable	Category	Frequency	Percentage
Occupation	Hairdresser	1	2%
	Homemaker	1	2%
	Receptionist	1	2%
	Student	48	94%

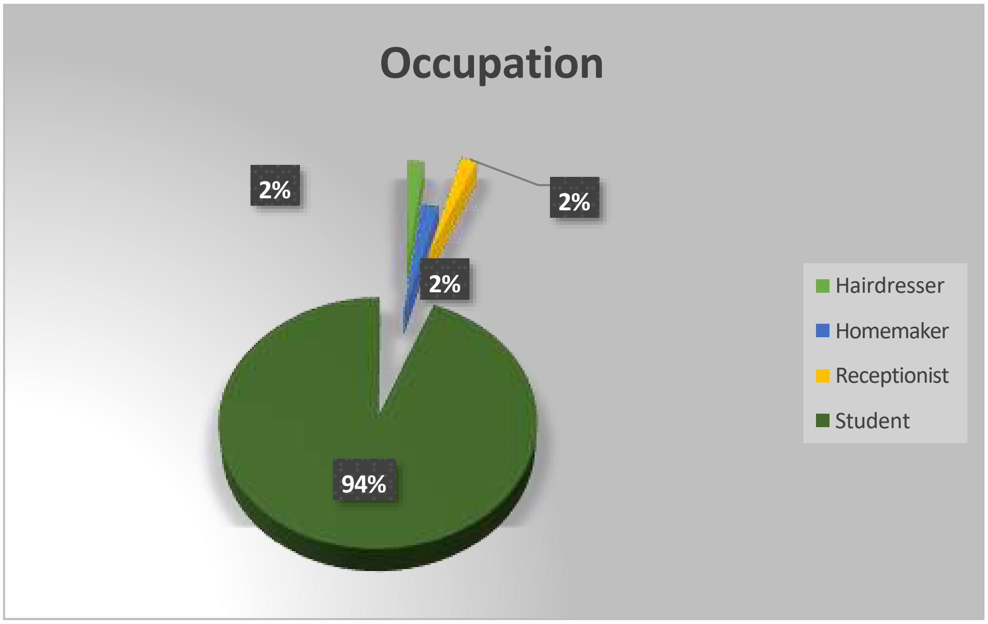

Figure 4.2: Occupation distribution

4.2.3 Height

The average height was 1.57 m, with a standard deviation of 0.058. The tallest individual was 1.71 m tall while the shortest was 1.44 m tall. The median height was 1.58 m while the lower quartile was 1.54 m and the upper quartile was 1.62 m. This means that the interquartile range was 0.08 m. **Figure 4.3** shows the height distribution of the sample population, which illustrates that the distribution is almost normal.

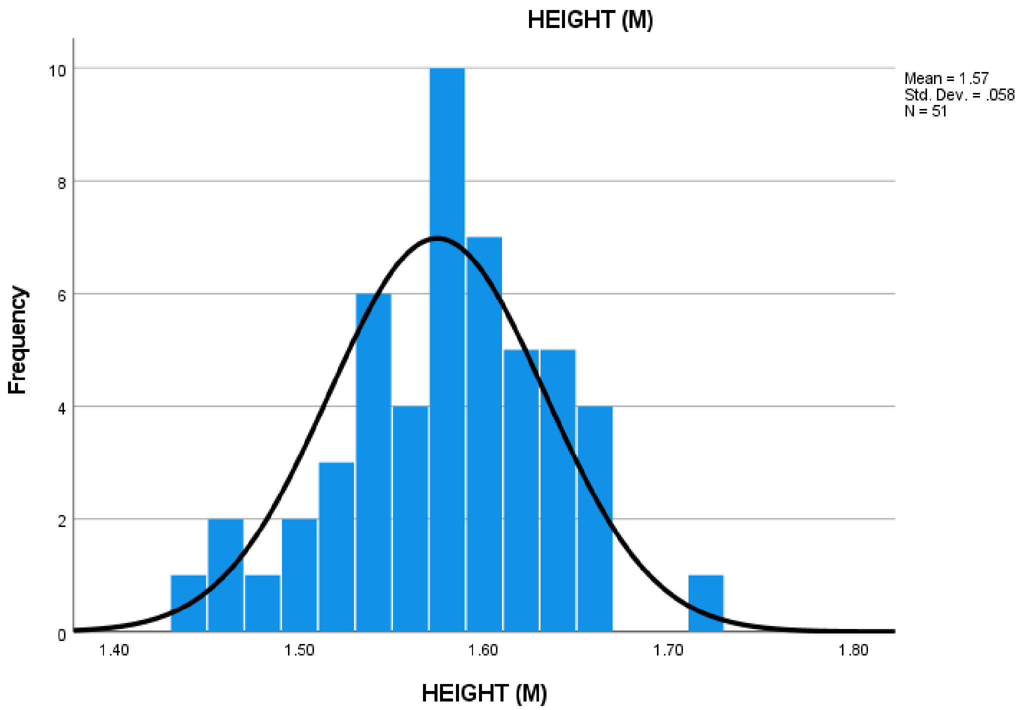

Figure 4.3: Height distribution among the participants

4.2.4 Weight

The average weight of the sample population was 66.8 kg with a standard deviation of 15.63 kg. The maximum weight was 120 kg and the minimum was 38.4 kg. The lower quartile weight was 57 kg, while the median weight was 65 kg. The upper quartile value was 72.9 kg. The corresponding interquartile range was 15.9 kg. **Figure 4.4** shows the weight distribution of the participants. It can be seen that the distribution is almost normal but with more values on the extreme upper end as compared to the lower end.

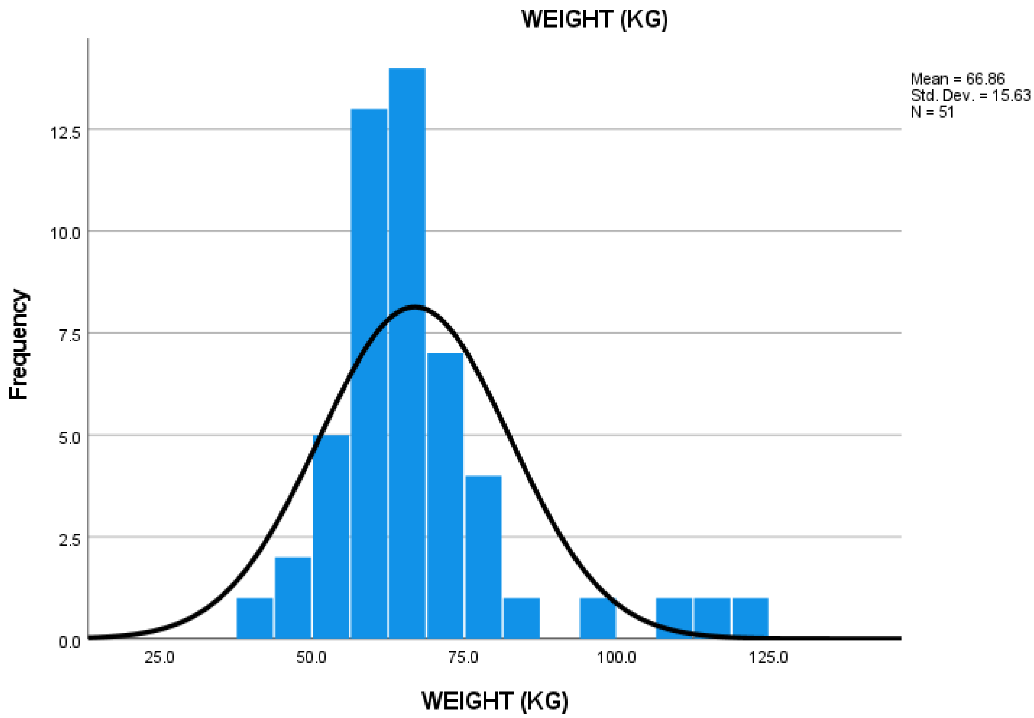

Figure 4.1: Weight distribution

4.2.5 Body Mass Index

Table 4.3 and **Figure 4.5** indicate that nearly half of the participants were classified as overweight (45.1%), while 35.3% were classified as normal. Those in the extreme were 17.6% classified as obese and 2% classified as underweight. The mean BMI for the participants was 26.9, with the lower quartile percentile being 23.12, indicating that 25% of the respondents were below that value. The median was 26.37, and, as such, half of the respondents were above and below this value. The interquartile range was 5.316, indicating that the middle 50% of the values were spread within the 5.13 units.

Table 4.3: Body mass index (BMI) variable of sample population

Demography variable	Category	Frequency	Percentage
BMI classification	Underweight (<18.5)	1	2.0%
	Normal (18.5-24.9)	18	35.3%
	Overweight (25-29.9)	23	45.1%
	Obese (>30)	9	17.6%

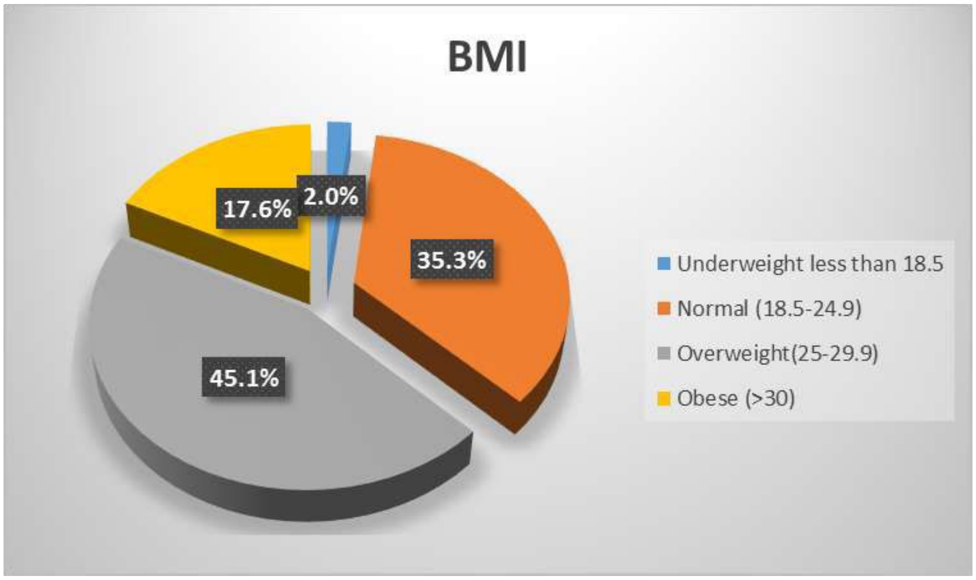

Figure 4.2: Body Mass Index (BMI) distribution

4.2.6 Craniovertebral Angle - Seated

The mean CVA while seated was 41.88°, with a standard deviation of 5.22°. The maximum CVA was 53.4° and the minimum was 27.3°. This gave a range of 26.1°. The lower quartile value was 38.7°, meaning that 25% of the respondents had an angle less than or equal to 38.7°. The median was 43.4°, while the upper quartile was 45°. The interquartile range was 6.3°. **Figure 4.6** shows that the data distribution is almost normal with the peak values slightly on the right of the normal curve centre.

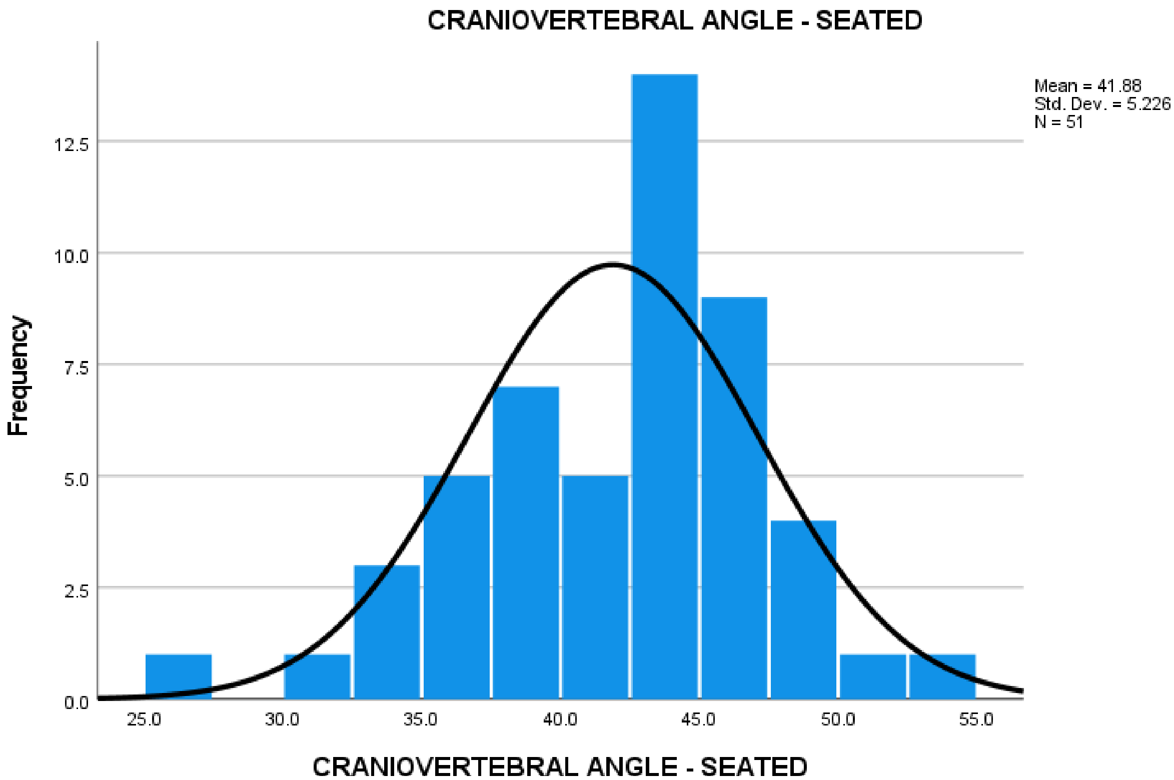

Figure 4.3: Distribution of CVA while seated

4.2.7 Craniovertebral Angle - Standing

The average CVA while standing was 37.15°, with a standard deviation of 4.29°. The maximum CVA was 45° and the minimum was 28.2°. This gave a range of 16.8°. The lower quartile value was 33.7°, while the median was 37.1° and the upper quartile was 40.6°. The interquartile range was 6.9°. **Figure 4.7** illustrates that most values are around the centre but with seemingly two peaks. The distribution is less normal than that of the CVA while seated.

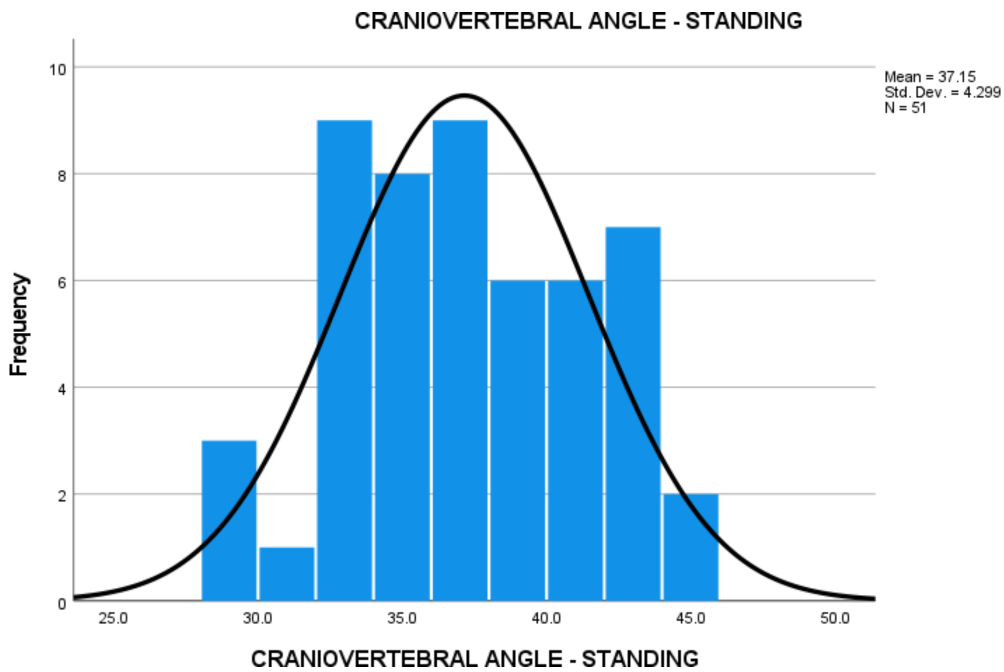

Figure 4.4: Distribution of CVA while standing

4.2.8 Comparison of Craniovertebral Angle Measurements

Table 4.4 is a summary of the descriptive statistics found in the sample population for CVA - seated, CVA - standing, height, weight and body mass index (BMI).

Table 4.4: Descriptive statistics of craniovertebral angle (CVA)-seated, craniovertebral angle (CVA)-standing, height, weight and body mass index (BMI)

	CVA-SEATED (º)	CVA-STANDING (º)	HEIGHT (m)	WEIGHT (kg)	BMI (kg/m^2)
Mean	41.884	37.149	1.5745	66.863	26.9039
Median	43.4	37.1	1.58	65	26.3702
Standard Deviation	5.2262	4.2991	0.05832	15.6296	5.67427
Variance	27.313	18.482	0.003	244.284	32.197
Range	26.1	16.8	0.27	81.6	30.36
Minimum	27.3	28.2	1.44	38.4	16.19
Maximum	53.4	45	1.71	120	46.55
25^{th} Percentile	38.7	33.7	1.54	57	23.1247
50^{th} Percentile	43.4	37.1	1.58	65	26.3702
75^{th} Percentile	45	40.6	1.62	72.9	28.441

Figure 4.8 shows the differences between the two CVA measurements. It can be seen that the CVA is generally higher when seated as compared to when standing. According to Figure 4.8, 50% of the CVA standing is less than 25% of the CVA while seated.

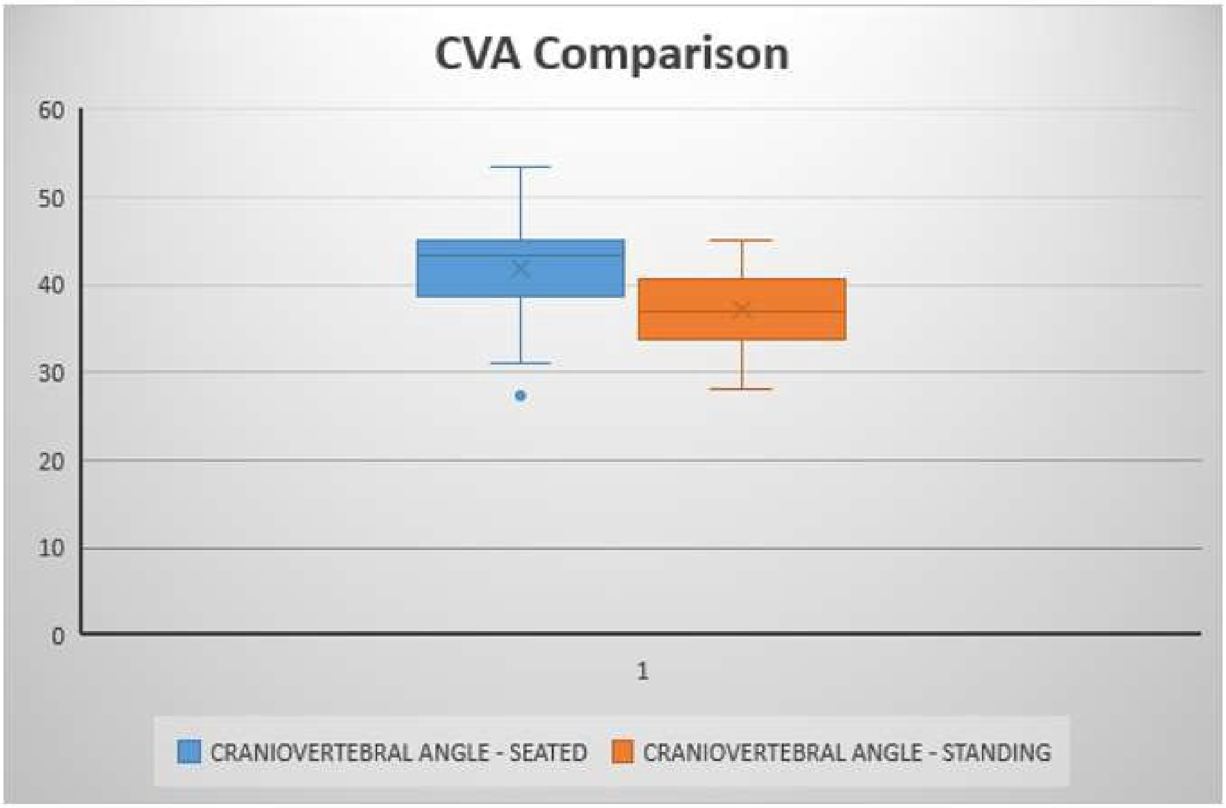

Figure 4.8: CVA while seated versus with CVA while standing

For a formal statistical comparison, the paired samples t-test was performed. The results are shown in **Table 4.5**. From the results, the *t* value is 8.009 with a *p*-value <0.001. This means that we reject the null hypothesis that the two groups means are equal and conclude that the two CVAs are significantly different. This then justifies the graphical observations that CVA is increased while seated, as compared to standing (**Figures 4.6, 4.7 and 4.8**).

Table 4.5: Comparison between craniovertebral angle (CVA) – seated versus craniovertebral angle (CVA) standing

Paired Samples t-Test		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	df (°)	*p*
Pair 1	CVA SEATED and CVA STANDING	4.7353	4.2222	.5912	3.5478	5.9228	8.009	50	.000

p=*p* value<0.05 is considered as significant; df =degrees of freedom; t= t-statistic;

4.2.9 The correlations Between the Age, Height, Weight, Body Mass Index, Craniovertebral Angle – Seated and Craniovertebral Angle Standing

Table 4.6 shows the correlations of the variables. The figures in bold in **Table 4.6** indicate significant correlations found in the study. Height and weight have a significant weak positive correlation of 0.383. Weight and BMI have a significant strong positive correlation of 0.947. This is not surprising as BMI considers weight. There was a weak positive significant correlation of 0.32 between weight and the CVA whist seated. A similar result was observed in the correlation of weight and CVA standing, which was a weak positive 0.388.

Similar to the weight, the BMI had a significant weak positive correlation with the CVA measurements. This is not surprising as the correlation between BMI and weight was very high. The correlation between BMI and CVA seated was a weak positive one of 0.320 while the CVA standing was 0.391. The CVA while standing had a significant positive correlation of 0.622 when compared with CVA seated.

Table 4.6: Correlations between the age, height, body mass index, craniovertebral angle – seated and craniovertebral angle – standing

Correlations

		AGE	HEIGHT	WEIGHT	BMI	CVA - SEATED	CVA- STANDING
AGE	Pearson Correlation	1	.015	.023	.017	.102	.055
	Sig. (2-tailed)		.915	.872	.905	.478	.703
HEIGHT	Pearson Correlation	.015	1	**.383****	.074	.115	.103
	Sig. (2-tailed)	.915		**.006**	.606	.420	.472
WEIGHT	Pearson Correlation	.023	.383**	1	**.947****	**.324***	**.388****
	Sig. (2-tailed)	.872	.006		**.000**	**.020**	**.005**
BMI	Pearson Correlation	.017	.074	.947**	1	**.320***	**.391****
	Sig. (2-tailed)	.905	.606	.000		**.022**	**.005**
CVA- SEATED	Pearson Correlation	.102	.115	.324*	.320*	1	**.622****
	Sig. (2-tailed)	.478	.420	.020	.022		**.000**
CVA - STANDING	Pearson Correlation	.055	.103	.388**	.391**	.622**	1
	Sig. (2-tailed)	.703	.472	.005	.005	.000	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4.2.10 Tests for Independence

A range for CVA for both seated and standing values was created and divided into three categories for each, which can be found in **Table 4.4**. The low range, which was the twenty-fifth percentile of each group (38.7 and 33.7 respectively), then the middle range, which was the twenty-fifth to the seventy-fifth percentile, (38.7 to 45.0 and 33.7 to 40.6 respectively) and lastly the high range, which was from the seventy-fifth to hundredth percentile (45.0 to 53.4 and 40.6 to 45.0 respectively).

A total of 50% was allocated for the middle as it was shown that the distribution is almost normal, and most values are in the middle, as can be seen in **Figures 4.6 and 4.7**. This would, in a normal situation, be the general population range while the low and high may be the rare cases.

To carry out the test for association, the chi-square test was attempted but was changed for the Fisher exact test which is more robust for low sample sizes with low and empty cell counts. The results are shown in **Table 4.7**.

Table 4.7: Tests for independence

Association Variables	Fishers Exact Test Value	*p*-value	Significance at 5%	Significance at 10%
CVA-Seated and Age Group	4.719	0.262	Not Significant	Not Significant
CVA-Seated and BMI	7.102	0.276	Not Significant	Not Significant
CVA-Standing and Age Group	2.234	0.753	Not Significant	Not Significant
CVA-Standing and BMI	10.239	0.071	Not Significant	Significant

4.3 CONCLUSION

Based on the results, it was found that CVA seated had a higher angle when compared to CVA standing. Age, height, weight, and occupation appeared to have no significant correlation to CVA while seated and CVA while standing. There seems to be no association between the CVA measurements and age range and CVA measurements and BMI at 5% level of significance. The same is concluded at 10% level of significance, except for CVA standing and BMI which is significant.

We also note that the age was predominantly within the 20 to 29 years' age range, which made up over three quarters of the sample population. Therefore, this may have had an effect on the conclusion.

CHAPTER 5

DISCUSSION

5.1 INTRODUCTION

In this chapter, the results of the study detailed in chapter four are interpreted and discussed by analysing and contrasting the observed research findings to that of the current literature. This process facilitates the results of the current study to be placed into a larger context which provides insights regarding the aims and objectives of the study.

5.2 OBJECTIVE OUTCOMES

This section entails a discussion of the results obtained which includes age, occupation, BMI and craniovertebral angle. This is followed by a discussion of the inferential analysis and factor analysis employed in this study.

5.2.1 Demographic and Selected Anthropometric Characteristics

The participants in this research were Black South African females between the ages of 18 to 45 years old. As majority of the sample included students, and this may have had an effect on the conclusion. In previous studies, various occupations were shown to have an effect on CVA (Akudo *et al*. 2015:16-22; Keerthana, Prathap and Preetha 2020:1818-1825). However, these studies investigated the association of a reduced CVA on musculoskeletal pain. As previously illustrated in **Table 4.1** and **Figure 4.1**, 78.4% of participants were between the ages of 20 to 29 years old and the mean age was 22.5 years old. Although age was shown to have no significance when compared to both craniovertebral angle seated and standing, the majority being in the 20 to 29 year age range may have influenced this. Therefore, age may have no association with CVA, which is similar to the findings of previous studies (Salahzadeh *et al*. 2014:131-139; Akudo *et al*. 2015:16-22, Kocur *et al*. 2019:195-202).

As shown in **Table 4.3** and **Figure 4.5**, 45.1% of the sample population were classified as overweight, while 35.3% were classified as normal, 17.6% were classified as obese and 2% were classified as underweight. The mean BMI for the participants was 26.9.

As illustrated in **Table 4.4**, height had no correlation with CVA seated and standing. However, it was observed that weight and BMI had a weak positive correlation to both CVA seated and standing measurements, which is consistent with the findings of studies where the Fisher exact test was utilised to test the association of BMI with CVA seated and CVA standing respectively. As observed in **Table 4.7**, BMI was found to have no significant association with CVA seated, but BMI was found to have a significant association with CVA standing at a significance of 10%.

These findings were consistent with those of Mitchell, Johnson and Adamson (2015:1172-1179), who also observed a weak positive correlation of BMI and CVA at a significance level of 0.05 (p = 0.035), however, these findings were incongruent with those of Brink *et al*. (2009:650) and Fard *et al*. (2016:3577,3581). The study by Brink *et al*. (2009:650) found a significant negative correlation with BMI and CVA, which is consistent with the findings by Fard *et al*. (2009:3577-3581) that also observed a significant negative correlation with CVA in standing position and concluded that individuals with greater BMI position were more likely to have a smaller CVA in standing position. They also noted that BMI appeared to have no association with CVA seated, which is consistent with the findings of the current study.

In the current study, the mean BMI was 26.9 with 45.1% of participants classified as "overweight," whereas the mean BMI found in studies by Brink *et al*. (2009:650) and Fard *et al*. (2016:3577,3581) were 20.4 and 20.9 respectively. As such, the average BMI of the current study being higher than the average BMI in the previous studies may suggest that they may not have been enough depth in the spread of BMI values to produce a significant correlation. In addition to this, previous studies also included symptomatic participants, and not just asymptomatic participants as with the current study, which may also have influenced the outcome.

5.2.2 The Craniovertebral Angle

Table 5.1 shows a comparison of the craniovertebral angle values previously reported in the literature with the current study.

Table 5.1: A comparison of craniovertebral angle values found in asymptomatic participants reported in the literature with the current study

Article (Author Year Published; Place)	*n*	F:M	Mean CVA (º) and SD - Seated	Mean CVA (º) and SD - Standing
Yip, Chiu and Poon 2008; Hong Kong	52	36:16	-	55.0 ± 2.9
Van Niekerk *et al* 2008 South Africa	13	7:6	47.6 ± 9.8	-
Brink *et al*. 2009; South Africa	93^	45:48	39.27 ± 8.0	-
Salahzadeh *et al*. 2014; Iran	78	78:0	-	55.0 ± 3.3
Akudo *et al*. 2015; Nigeria	150^	122:28	49.95 ± 8.32	-
Fard *et al*. 2016; Iran	25	Not mentioned	46.5 ± 3.0	52.7 ± 2.8
Kim and Kim 2016; South Korea	126	31:95	59.7 ± 6.9	61.4 ± 5.7
Abbaszadeh-Amirdehi *et al*. 2018; Iran	16	13:3	60.5 ± 4.5	57.5 ± 4.9
Cote *et al*. 2021; USA	66	56:10	-	50.6 ± 6.2
*Antony 2022; South Africa	51	51:0	41.88 ± 5.22	37.15 ± 4.29

n = number of participants; CVA = craniovertebral angle; SD = standard deviation; f:m = female: male ratio; n^ = sample size includes both symptomatic and asymptomatic; *=current study

The study found that the mean CVA while seated was 41.88° with a standard deviation of 5.22°. The maximum CVA when seated was 53.40° and the minimum was 27.30°. This was similar to the findings of Brink *et al*. (2009:647-653) but inconsistent to other previous studies (van Niekerk *et al*. 2008:113; Fard *et al*. 2016:3577-3582; Kim and Kim 2016:309-313; Abbaszadeh-Amirdehi *et al*. 2018:85-88) that observed much higher values. However, these studies had included both male and female participants which may have influenced the results. No other studies, to the researcher's knowledge, were found to have been done that observed seated CVA measurements for females only.

The mean CVA while standing was 37.15° degrees, with a standard deviation of 4.29°. The maximum CVA was 45.0° and the minimum was 28.2°. These findings varied significantly with those observed in previous studies (Yip, Chiu and Poon 2008:148-154; Fard *et al*. 2016:3577-3582; Kim and Kim 2016:2929-2932; Abbaszadeh-Amirdehi *et al*. 2018:85-88; Cote *et al*. 2021:1-9).

However, the majority of the above mentioned studies, which can be found in **Table 5.1,** investigated CVA as a possible association to musculoskeletal pain and did not exclude whether forward head posture was present or not, but rather used CVA as an indicator of FHP based on the literature. However, there is yet to be a generally accepted reference point found that also takes into account the various age groups, gender groups and race groups (Fernández-de-las-Peñas *et al*. 2006:662-672; Yip, Chiu and Poon 2008:148-154; Diab and Moustafa 2011:351-361; Ruivo, Pezarat-Correia and Carita 2014:365-371).

In addition to this, it has also been noted in the literature that musculoskeletal pain may not always be associated with FHP and vice versa (Ghamkhar and Kahlee 2019:346; Mahmoud *et al*. 2019:562). Although the study by Salahzadeh *et al*. (2014:133-139) conducted an observational study on the assessment of forward head posture in females, they too had divided participants with no FHP and those with FHP, based on the literature that had found that subjects with smaller CVA had more FHP, as no clear cut-off threshold had been established.

Pearson's correlation (**Table 4.6**) noted that CVA while standing had a significant positive correlation of 0.622 when compared with CVA seated. The paired samples t-test was performed to compare the two CVA measurements which were shown in **Table 4.5.** The results revealed a significant difference between CVA whilst seated and CVA while standing (p<0.001), which is similar to the findings of all the studies found in **Table 5.1,** except for the study by Kim and Kim (2016:2929-2932) which found no significant difference between the CVA measurements. As illustrated in **Figure 4.8**, CVA is generally higher when seated as compared to when standing.

The difference observed between the two CVA measurements may be due to the standing position being more sensitive than the seated position to factors such as BMI, which has found that obesity may cause postural changes due to the shift of the centre of gravity, which may not have been observed while seated (Fard *et al*. 2016:3581; Thajer *et al*. 2021:288). These findings are consistent to those of Abbaszadeh-Amirdehi *et al*. 2018:85-88), but inconsistent to those of Fard *et al*. (2016:3577-3582) and Kim and Kim (2016:2929-2932). Therefore, the null hypothesis that the two group means are equal was rejected and it was concluded that the two CVA measurements are significantly different.

5.3 CONCLUSION

According to the above discussion, it can be seen that there is significant variation between the craniovertebral measurements of the current study to previous literature. This may be due to the different methods used to measure CVA, as well as the differences in the sample population. It was found that CVA while seated was higher than CVA while standing. Although, age and occupation did not have appear to have any significant correlation to the CVA measurements, BMI may have an effect on CVA.

The findings for this study may be considered as a characteristic for asymptomatic Black South African females. The reason asymptomatic individuals were selected for this study was because symptomatic participants might have influenced the results. In addition to this, to allow for homogeneity, as measurements may vary among the various ethnic groups and among gender, only Black South African females were included in this study, as the aim of the study was to establish a standardised range for normal craniovertebral angle among Black South African females to be used for clinical and research reference.

CHAPTER 6

CONCLUSION

6.1 INTRODUCTION

This is the final chapter which highlights the significant research findings obtained to provide a brief summary of the results of this research study in its appropriate context. It also aims to highlight the limitations that were met with this specific research study. In addition, it also intends to provide recommendations for future studies.

6.2 CONCLUSION

The study investigated craniovertebral angle among Black South African females to determine a standardised range for this particular population group, as CVA may vary among the different gender and race groups. The mean CVA while seated was 41.88° with a standard deviation of 5.226°; and the mean CVA whilst standing was 37.15° with a standard deviation of 4.299°. It is observed that when comparing CVA seated and CVA standing, that the two CVAs are significantly different and that CVA is increased whilst seated, as compared to standing. It is also observed that there appears to be no association between the CVA measurements and age, and CVA measurements and BMI, at 5% level of significance. The same is concluded at 10% level of significance, except for CVA standing and BMI which is shown to have a significant association.

These results may be used a guideline for a normal seated and standing CVA reference point for Black South African females which will better enable clinicians in the treatment and prophylactic treatment of FHP, as it has been associated with musculoskeletal pain, which can be self-limiting and results in an economic burden. However, it must be noted that these findings were derived from a pilot study and ideally, a full study should be conducted to establish a more accurate range.

Therefore, the study rejected the null hypothesis that the two groups (i.e. CVA seated and CVA standing) are equal and concludes that the CVA seated and standing is significantly different.

6.3 RESEARCH LIMITATIONS

The present study has a few limitations. Firstly, a pilot study was conducted due to the paucity in the literature, particularly in a South African context, with a sample size of 51 individuals, due to time and human resource constraints amid the COVID-19 pandemic.

Secondly, all participants were required to be between the ages of 18 and 45 years. The lower age limit is necessary to avoid including participants who cannot give consent of their own free will and the upper age limit is necessary to avoid age-related degeneration (Yochum and Rowe 2005:2,988).

Thirdly, to allow for homogeneity, only Black South African females were included in this study.

Lastly, the majority of the sample included students within the age group of 20 to 29 years. As such, caution is advised against the generalisation of the findings for all ages, as well as for other ethnic and gender groups, but the findings may be used as a guideline for clinical practice and research.

6.4 RECOMMENDATIONS

The recommendations arising from this study include the following:

- As this study was a pilot study, a study using a larger sample size should be considered to obtain more objective data that may produce a greater statistically significant result.
- Similar studies could be conducted that include males and females of different race groups to observe and compare any similarities or differences regarding CVA measurements.

- Additional research is needed to determine the intra-examiner and inter-examiner reliability of the CVA measurements using the Posture Pro Software Analysis.
- Additional research may be required to compare CVA measurements among non-FHP groups and FHP groups to determine any statistically significant findings.
- Further studies may be warranted to compare the Posture Pro Software Analysis with standard radiographic and photographic methods in measuring CVA.
- This study should be made available to chiropractors and other physicians to better enable them to identify and quantify FHP, which may aid in determining the effectiveness of treatment modalities and enable them to assess patient prognosis.

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APPENDICES

Appendix A: Ethhical Clearance Certificate

DUT DURBAN UNIVERSITY OF TECHNOLOGY
INSTITUTIONAL RESEARCH ETHICS COMMITTEE

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

7 July 2021

Ms R Antony
[redacted]

Dear Ms Antony

Normal craniovertebral angle range in asymptomatic Black South African females: A pilot study
Ethical Clearance number IREC 057/21

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

Prof J K Adam
Chairperson: IREC

Appendix B: Permission Letter

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

21 May 2021
Ms Reenu Antony
c/o Department of Chiropractic and Somatology
Faculty of Health Sciences
Durban University of Technology

Dear Ms Antony

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 **Gatekeeper Permission** for you to conduct your research "Normal craniovertebral angle range in asymptomatic Black South African females: A pilot study" at the Durban University of Technology. **Kindly note that this letter must be issued to the IREC for approval before you commence data collection.**

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 would be submitted to the IRIC on completion of your studies.

Kindest regards.
Yours sincerely

DR LINDA ZIKHONA LINGANISO
DIRECTOR: RESEARCH AND POSTGRADUATE SUPPORT DIRECTORATE

APPENDIX C: Gatekeeper's Letter

24 June 2021

Attention:
Ms Reenu Antony [redacted]

[redacted]

Dear Ms Antony
RE: GATEKEEPER PERMISSION TO CONDUCT RESEARCH
Gatekeeper's permission is hereby granted for you to conduct research at the Durban University of Technology, provided Ethical clearance has been obtained. We note the title of your research project submitted to the Institutional Research Ethics Committee (IREC). as: *"Normal craniovertebral angle range in asymptomatic Black South African females: A pilot study."*
As per your proposal, you have requested permission to utilise the DUT Chiropractic Day Clinic and the equipment, mainly a consultation room with an examination bed, a chiropractic bed, the use of the Posture Pro Software Analysis (developed by Ventura Design©) and its relevant equipment.

Please note that gatekeeper approval means that the researcher needs to adhere to the following conditions:
• No data collection can commence prior to full approval of your study by the IREC
• Prior arrangements need to be made with the facility and an assurance that clinic services will not be disrupted.
• Ethical clearance number needs to appear in all your data collection instruments;
• Always display Research title and details of the research, the researcher and the supervisor;
• Identity numbers and email addresses of individuals are not a matter of public record and are protected according to Section 14 of the South African Constitution, as well as the PAIA and POPI Act. For the release of such information over to yourself for research purposes, the Durban University of Technology will need to express consent from the relevant data subjects.
• All collected data must be treated with due confidentiality and anonymity.

Yours sincerely

Professor G G Mchunu
Executive Dean: Faculty of Health Sciences
Durban University of Technology

From the Office of the Executive Dean: Faculty of Health Sciences, Professor G G Mchunu
[redacted]

ARE YOU BETWEEN THE AGES OF 18 – 45 YEARS?

FREE HEAD AND NECK POSTURAL ASSESSMENT

ELIGIBLE FOR BLACK FEMALES WITH NO NECK PAIN

Research is being conducted at the Durban University of Technology Chiropractic Day Clinic

For more information or to participate, please contact Reenu on [redacted]

APPENDIX D: Prospective Questions

Telephonic Screening

Questions for prospective participants	**Expected answers**
Please may I ask you some questions?	Yes
Are you between the ages of 18 and 45 years?	Yes
Which of the following best represents your ethnicity? Black African; White; Coloured; Indian/Asian; other	Black African
Do you currently have neck pain?	No
Do you have a history of neck pain in the last three months?	No
Are you pregnant by any chance?	No
Have you had any surgery to the neck?	No

Appendix F1: Letter of Information (English)

LETTER OF INFORMATION

Title of the Research Study: Normal craniovertebral angle range in asymptomatic Black South African females: A pilot study

Co-Investigator/s/supervisor/s: Ms. Reenu Antony, B.Tech: Chiropractic

Co-Investigator/s/supervisor/s: Dr. D. Varatharajullu, M.Tech: Chiropractic and Dr. Y. Venketsamy, M.Tech: Chiropractic

Brief Introduction and Purpose of the Study: Abnormal posture is becoming more and more common in modern times. Forward head posture is an example of abnormal posture and has become more prevalent in recent times due to the advancing pace of technology and the increase in usage of devices such as smartphones and computers. This abnormal posture puts strain on the joints and muscles of the head and neck which may result in neck pain and headaches. The aim of this study is to determine a standardised range for CVA among Black South African females to be used as a clinical and research reference.

Dear participant, welcome to my study.

I am a 6th year student at DUT doing research for my M.Tech in Chiropractic.

I would like to invite you to participate in my research. Thank you for your cooperation.

What is research? Research is a systematic search or enquiry for generalized new knowledge.

Outline of the Procedures: You as the participant will be required to answer several questions, telephonically, in order to determine eligibility for the study. Once accepted, you will be booked a date and time at the Durban University of Technology Chiropractic Day Clinic. This appointment will be conducted in a private consultation room. You will be required to sign an informed consent form and the study procedure will then be explained to you. Reflective markers will be placed by the ear and at the base of the neck. After the reflective markers are placed, you will undergo a free photographic postural screening. Your identity will be protected when photographs are being taken as your face will be censored. Two photographs will be taken, one with you sitting on a chair and one with you standing. This is a once-off session and you are not required to come back for a follow-up visit. Time needed for the entire session will be approximately 30 to 45 minutes. No treatment or interventions will be administered

Risks or Discomforts to the Participant: There are no health risks nor discomforts foreseen in this study but you may report any discomfort to the researcher at any point in time.

Explain to the participant the reasons he/she may be withdraw from the Study: You may withdraw from the study at any point in time without any consequences.

Benefits: Free head and neck postural assessment.

Remuneration: You will not be receiving any form of remuneration for taking part in this study.

Costs of the Study: You will incur travelling costs for the trip to the Durban University of Technology Chiropractic Day Clinic.

Confidentiality: Confidentiality will be maintained, as data collection will be anonymous and no names will be recorded on the data collection sheets.

Results: Results will be made available as a dissertation at the DUT library and online in the institutional repository

Research-related Injury: No research-related injury is forseen in this study. Should any injury occur, there will be no compensation for it.

Storage of all electronic and hard copies including tape recordings: All data of the study will be securely kept by the researcher. After the study is concluded, all documents and/or any electronic data will be stored at the Chiropractic Department for a period of five years and be shredded thereafter and any electronic data will deleted from a USB.

Persons to contact in the Event of Any Problems or Queries: Please contact the researcher (081 209 7340), my supervisor/co-supervisor (031 373 2533/031 373 2588) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za.

Appendix F2: Letter of Information (isiZulu)

LETTER OF INFORMATION / INCWADI YOLWAZI

Umcubungulu omkhulu/umcwaningi: Ibanga elijwayelekile le-craniovertebral angle kuma-asymptomatic abesifazane baseNingizimu Afrika abamnyama: isifundo sokushayela indiza

Umphenyi Oyinhloko: Ms. Reenu Antony, B.Tech Chiropractic

Umphathi/usekela mphathi: Dr. D. Varatharajullu, M.Tech Chiropractic noDr. Y. Venketsamy, M.Tech Chiropractic

Incazelo emfishane nenhloso ngalolucwaningo: Ukuma okungajwayelekile kuya ngokuya kuvame ezikhathini zanamuhla. Ukuma phambili kwekhanda kuyisibonelo sokuma okungajwayelekile futhi sekuvame kakhulu ezikhathini zamuva ngenxa yokuthuthuka kwezobuchwepheshe nokwanda kokusetshenziswa kwamadivayisi afana nama-smartphone namakhompyutha. Lokhu kuma okungajwayelekile kubeka ubunzima emalungeni nasemisipha yekhanda nentamo okungaholela ebuhlungu bezintamo nekhanda. Inhloso yalolu cwaningo ukuthola ibanga elilinganiselwe le-CVA phakathi kwabesifazane abaNsundu baseNingizimu Afrika elizosetshenziswa njengereferensi yomtholampilo nocwaningo.

Mhlanganyeli othandekayo, wamukelekile esifundweni sami.

Ngingumfundi wonyaka we-6 eDUT ngenza ucwaningo ngeM.Tech yami eChiropractic.

Ngingathanda ukukumema ukuthi ubambe iqhaza ocwaningweni lwami. Siyabonga ngokubambisana kwakho.

Luyini ucwaningo? Ucwaningo ukusesha okuhlelekile noma ukubuza ngolwazi olusha olwenziwe jikelele.

Uhlaka Lwezinqubo: Wena njengomhlanganyeli kuzodingeka uphendule imibuzo eminingana, ngocingo, ukuze unqume ukufaneleka kocwaningo. Uma uswamukelwe, uzobhukelwa usuku nesikhathi eDurban University of Technology Chiropractic Day Clinic. Lokhu kuqokwa kuzokwenziwa egumbini lokubonisana elizimele. Kuzodingeka ukuthi usayine ifomu lokuvuma unolwazi bese uchazelwa inqubo yokufunda. Omaka ababonakalisayo bazobekwa yindlebe nangaphansi kwentamo. Ngemuva kokubekwa komaka ababonayo, uzohlolwa isithombe samahhala sangemuva kwesithombe. Ubunikazi bakho buzovikelwa lapho izithombe zithathwa njengoba ubuso bakho buzohlolwa. Kuzothathwa izithombe ezimbili, esisodwa sihlale esihlalweni kanti esinye simile. Lesi yisikhathi esivela kanye futhi awudingi ukuthi ubuye ukuzohambela ukulandela. Isikhathi esidingekayo sesikhathi sonke sizoba cishe imizuzu engama-30 kuye kwengama-45. Akukho ukwelashwa noma ukungenelela okuzokwenziwa

Izingozi noma ukungahambi kahle kulowo obambe iqhaza: Azikho izingcuphe zezempilo noma ukungakhululeki okubikezelwe kulolu cwaningo kodwa ungabika noma yikuphi ukungaphatheki kahle kumcwaningi nganoma yisiphi isikhathi.

Chazela obambe iqhaza izizathu zokuthi angahoxa kanjani ocwaningweni: Ungaphuma ocwaningweni nganoma yisiphi isikhathi ngaphandle kwemiphumela.

Izinzuzo: Ukuhlolwa kwangemuva kwekhanda nentamo kwamahhala.

Umholo: Ngeke uthole noma yiluphi uhlobo lomholo ngokubamba iqhaza kulolu cwaningo.

Izindleko Zesifundo: Uzoba nezindleko zokuhamba ngohambo oluya eDurban University of Technology Chiropractic Day Clinic.

Imfihlo: Ukugcinwa kwemfihlo kuzogcinwa, ngoba ukuqoqwa kwedatha kuzobe kungaziwa futhi akukho magama azorekhodwa kumashidi okuqoqwa kwedatha.

Imiphumela: Imiphumela izotholakala njengothishela emtatsheni wezincwadi wase-DUT naku-inthanethi endaweni yokugcina izikhungo

Ukulimala okuhlobene nocwaningo: Akukho ukulimala okuhlobene nocwaningo okubonakala kulolu cwaningo. Uma kwenzeka kwenzeka noma yikuphi ukulimala, ngeke kube khona ukukhokhelwa ngakho.

Ukugcinwa kwawo wonke amakhophi kagesi nawamakhompiyutha afaka okuqoshiwe kwamateyipu: Yonke imininingwane yocwaningo izogcinwa ngokuphephile ngumcwaningi. Ngemuva kokuphothulwa kocwaningo, yonke imibhalo kanye / noma enye idatha ye-elekthronikhi izogcinwa eMnyangweni weChiropractic isikhathi esiyiminyaka emihlanu bese ishiswa ngemuva kwalokho futhi noma iyiphi idatha ye-elekthronikhi izosuswa kwi-USB.

Abantu Bokuthintana Nabo Uma Kuvela Noma Iziphi Izinkinga Noma Imibuzo:
Sicela uthinte umcwaningi (081 209 7340), umphathi wami / usekela mphathi wami (031 373 2533/031 373 2588) noma i-Institutional Research Ethics Administrator ku-031 373 2375. ubikwe kuMqondisi: Wokusekelwa Kwezokucwaninga kanye Nabafundi Abaphothule Iziqu zabo uDkt L Linganiso ku-031 373 2577 noma ku-researchdirector@dut.ac.za.

Appendix G1: Letter of Consent

CONSENT

Full Title of the Study: Normal craniovertebral angle range in asymptomatic Black South African females: A pilot study

Names of Researcher/s: Ms. Reenu Antony

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, ____________ (Reenu Antony), about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: IREC 057/21.
- 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, Reenu Antony, 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 G2: Letter of Consent (isiZulu)

CONSENT/IMVUME

Isihloko Esigcwele Sesifundo: Ibanga elijwayelekile le-craniovertebral angle kuma-asymptomatic Abesifazane baseNingizimu Afrika: Isifundo sokushayela

Amagama oMcwaningi: Reenu Antony

Isitatimende sesivumelwano sokuzibandakanya kulolucwaningo:

- Ngiyaqinisekisa ukuthi ngazisiwe ngumcwaningi, Reenu Antony, mayelana nohlobo, ukuziphatha, izinzuzo kanye nezingozi zalolu cwaningo - Research Ethics Clearance Inombolo: IREC 057/21.
- Sengithole, ngafunda futhi ngaluqonda ulwazi olubhaliwe olungenhla (Incwadi Yomhlanganyeli ka Imininingwane) maqondana nesifundo.
- Ngiyazi ukuthi imiphumela yocwaningo, kubandakanya imininingwane yomuntu mayelana nobulili bami, iminyaka, usuku lokuzalwa, ama-initials kanye nokuxilongwa kuzocutshungulwa kungaziwa kube wumbiko wocwaningo.
- Ngenxa yezidingo zocwaningo, ngiyavuma ukuthi idatha eqoqwe phakathi nalolu cwaningo ingacutshungulwa ngohlelo lwekhompyutha ngumcwaningi.
- Ngingahle, noma ngasiphi isigaba, ngaphandle kokubandlulula, ngihoxise imvume yami futhi ngibambe iqhaza ocwaningweni.
- Ngibe nethuba elanele lokubuza imibuzo futhi (ngentando yami) ngizibonakalise ngikulungele ukubamba iqhaza ocwaningweni.
- Ngiyakuqonda ukuthi okutholakele okusha okubalulekile kuthuthukiswe phakathi nalolu cwaningo okungenzeka maqondana nokubamba kwami iqhaza kuzotholakala kimi.

gama lomzali/umvikeli osemthethweni	**Usuku**	**isikhathi**	**isiginisha/isithupha**

Mina Reenu Antony ngiyaqinisekisa ukuthi lomzali/umvikeli osemthethweni uthole incazelo egcwele mayelana nohlobo, ngokuziphatha, nangosizo, nangobungozi balolucwaningo

Igama lomucwaningi	**Usuku**	**Isiginesha**
Igama likafakazi (Uma kukhona)	**Usuku**	**Isiginesha**
Igama eligcwele Lombheki Wezomthetho (Uma kukhona)	**Usuku**	**Isiginesha**

Appendix H: Data Collection Tool

<u>Data Collection Sheet</u>

CODE NO: ________________

1. Demographic Data

Age	
Occupation	
Height (m)	
Weight (kg)	
Body mass index (kg/m^2)	

2. Measurement

Craniovertebral angle (°) – SEATED	
Craniovertebral angle (°) – STANDING	