The effect of craniocervical flexion exercise on cervical posture and cervical range of motion in asymptomatic participants

By

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

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Approved for final examination

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Dr G. Matkovich, M.Tech: Chiropractic Date

Dedication

I would like to dedicate this dissertation to my parents Evangelos and Priscilla Camitsis for their constant and unconditional support during my time so far on this earth. I love you both dearly.

My sister Sabrina for keeping me focused on the things that matter.

My brother Sherwin for making me realize the tangled network of decisions that is the result of being alive.

To Kirsty for giving me her selfless support on this journey.

Thank you for being a part of this journey.

I send you all love and respect.

"Give me a lever long enough and a fulcrum on which to place it and I shall move the world" (Archimedes).

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Abstract

Background: Forward head posture (FHP) is a common postural abnormality that is commonly associated with weak deep cervical flexor muscles (DCF). The craniovertebral (CV) angle lies between a horizontal line running through C7 spinous process and a line connecting the C7 spinous process to the tragus of the ear. The smaller the angle, the greater the forward head posture. Weak DCF musculature and FHP has been linked to cervical dysfunction in the short and long term such as cervicogenic headache and premature development of cervical regional degenerative joint disease. Improving isometric endurance and neuromotor control of the DCF muscles using craniocervical flexion exercise (CCFE) has been shown to be efficient in patients experiencing cervical dysfunction such as headache, although the relevance of CCFE has not been established in the asymptomatic group. Deficiency in the activity of these muscles can be accurately measured using craniocervical flexion testing (CCFT).

There is a paucity of information regarding the definitive relationship between weakness of the DCF and FHP in asymptomatic participants. This research will help establish an efficient and safe prophylactic treatment protocol preventing long term sequela associated with FHP.

Objectives: To determine the effect of CCFE on cervical posture by assessment of the CV angle in asymptomatic participants as well as to determine the effect of CCFE on cervical range of motion by assessment of flexion, extension, bilateral rotation and lateral flexion movements in asymptomatic participants whilst measuring the effect of CCFE on isometric endurance and neuromotor control of the DCF muscles assessed by the CCFT in asymptomatic participants.

Method: This is a quantitative pre/post intervention study comparing the results of one group of 45 asymptomatic participants before and after the CCFE protocol has been allocated to them over a period of 3-5 weeks. Participants FHP was assessed by measuring the CV angle. This was done by marking the C7 spinous process and extending a horizontal line toward the shoulder. Then marking the tragus of the ipsilateral ear and measuring the angle using the smart tool angle finder (MD products).

CCFT measurements were taken and the CCFE protocol allocated to those who qualified to take part in the study. Lastly, cervical range of motion was measured.

This group received a home exercise protocol of 3 sets of 10 supine chin tucks daily with each repetition being held for 10 seconds. The technique was first ensured by the researcher prior to leaving the consultation rooms and an exercise diary was given to the participant until the 5th and final consultation to record the progress and efficiency of the home programme as well as any complaints regarding this.

Result: The asymptomatic group included in the study improved in both the seated and standing CV angle measurements in that the CV was greater at the conclusion of the pre/post intervention (p=0.00000002) and (p=0.000003) respectively . Cervical range of motion showed improvement in some but not all ranges. Flexion showed a reduction in range of motion (p=0.0086) which was significant. Extension showed an improvement in range of motion (p=0.0000002) which was significant. Rotation toward the left (p=0.00003) and right (p=0.00063) showed an improvement in range of motion which was significant. Lateral flexion showed improvement which was not significant in both, left (*p*=0.0145) and right (*p*= 0.24985) ranges of motion. Neuromotor control showed 100 percent improvement in that all 45 of the participants were able to perform CCFT correctly through all five stages at conclusion of the study.

Conclusion: Therefore it can be concluded that asymptomatic participants will benefit from CCFEs In terms of CV angle improvement, cervical range of motion as well as neuromotor control of the DCF muscles.

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Definitions and Abbreviations

CVagl : Craniovertebral angle. The angle formed between a horizontal line passing through C7 and a line extending from the tragus of the ear to C7 spinous process. The craniovertebral angle values indicate the degree of forward head position (Ho Ting Yip et al, 2007)

CCFT : Craniocervical flexion testing. A supine test measuring the neuromotor control and isometric endurance of the DCF muscles (Jull and Sterling, 2008)

CCFE : Craniocervical flexion exercise. A supine exercise used to improve DCF neuromotor control and isometric endurance (Jull and Sterling, 2008)

FHP : Forward head posture. Anterior shift of the head position, resulting in a movement of the body away from the center of gravity (Ho Ting Yip et al, 2007)

DCFs : Deep cervical flexors (Moore and Dalley, 1999)

BMI : Body mass index. BMI is a formula that combined the patient's weight and height. The actual formula= Weight/Height squared (Douglas *et al*, 2005).

Chapter One
Introduction

1.1 Introduction to the problem

Neck pain is generally defined as pain located between the base of the occiput and the third thoracic (T3) vertebrae (Cote *et al*, 2000). Pain in this region has a high prevalence in different population groups (Bovim *et al*, 1994; Cote *et al,* 2000; Guez *et al,* 1991; Ndlovu, 2006; Slabbert, 2010). The variation in the prevalence ranges from 67.7% of the Saskatchewan (Canadian) population (Cote *et al,* 2000), to 43.0% of the Swedish population (Guez *et al,* 2002), and 34.4% of Norwegian adult population (Bovim *et al,* 1994). In South Africa (specifically Durban), research indicates a 50.0% prevalence in the Black African / Indigenous population (Ndlovu, 2006), 45.0% in the White population (Slabbert, 2010) and 5% in the Indian population (Muchna, 2011).

Therefore, neck pain is a common and costly problem in society effecting 67% of people at some point in their lives (Schenk *et al,* 2008). In this context neck pain of mechanical origin constitutes approximately 45% - 50% of all neck pain (Fernandez des las Penas *et al*, 2007; Cote *et al*, 2008). In addition, cervical musculoskeletal abnormalities have been linked to several headache types making the prevention of this abnormality a priority (Fernandez des las Penas *et al*, 2007); as both mechanical neck pain and the associated headaches constitute a significant morbidity resulting in ever increasing costs to the patient, the employer and society in general.

This morbidity is increased when interventions are delayed or inappropriate, leading to increased incidents of mechanical neck pain, decreased resolution and increased chronicity with increasing age (Cassou *et al*, 2002).

In order to counteract the effects of mechanical neck pain, the manual practitioner (e.g. chiropractor) has several possible intervention options available, which include but may not be limited to manipulation and mobilization techniques (De Franca, 2000); Murphy, 2000; Bergmann and Peterson, 2002), soft tissue techniques (muscle energy techniques, stretches (static and isometric), massage techniques (ischemic compression), needling, active release techniques (Murphy, 2000; Chaitow and DeLany, 2000), traction , various electromodalities (Kitchen and Bazin, 2002).

The least invasive and least expensive of these interventions is the craniocervical flexion exercise (CCFE), as this can be done at home, by the participant, with fewer visits required to the practitioner. The effect of CCFE is on improving the deep cervical flexor (DCF) isometric endurance and neuromotor control (Jull *et al,* 2002). This particularly targets the deep cervical flexor group which is composed of longus capitus, longus colli, rectus capitus and rectus lateralis (Moore and Dalley, 1999; Standring, 2008). These muscles are of great importance where stabilization of the cervical spine is concerned (Jull *et al*, 2008); as the longus colli, longus capitus and rectus capitus anterior provide support (Falla *et al,* 2007) anteriorly countering the accentuation of the lordotic angle induced by the extensor muscles (Liebenson, 2007).

CCFE is an exercise protocol by which the participant was placed in the crook half lying position; the cervical spine was supported in a neutral position (Jull *et al*, 2008). The pressure biofeedback unit was placed between the plinth and the posterior aspect of the neck just below the occiput and inflated to a baseline of 20 mmHg. The participant was then instructed to perform a head nodding action to target sequentially five 2 mmHg progressive pressure increases from the baseline of 20 mmHg to a maximum of 30 mmHg as well as to hold the position steady in a low load endurance test, for the purpose of improving isometric endurance and neuromotor control of the DCF muscles (Liebenson, 2007).

Various studies have measured the effect of CCFE on head posture in participants with mechanical neck pain and headache (Jull *et al*, 2008; Falla, 2007) although little research has critically focused on the asymptomatic participant alone. The craniovertebral angle was used exclusively to measure the change in FHP and the relative improvement in DCF isometric endurance and neuromotor control (Jull *et al*, 2002) in addition to range of motion in the cervical spine.

Thus, if this research shows that CCFE is able to improve DCF isometric endurance and neuromotor control, normalize FHP (craniovertebral angle), it will allow for a cost effective, but clinically relevant tool to assist in the prevention of mechanical neck pain by means of a simple, patient driven exercise.

1.2 Aims and objectives of the study

The aim of the research was to measure the effect of CCFE on cervical posture and cervical range of motion in asymptomatic participants.

The Objectives:

- 1.2.1 The first Objective was to measure the effect of CCFE on cervical posture by assessment of the CV angle.
- 1.2.2 The Second Objective was to measure the effect of CCFE on cervical range of motion by assessment of flexion, extension and bilateral rotation and lateral flexion movements.
- 1.2.3 The Third Objective was to measure the effect of CCFE on isometric endurance and neuromotor control of the DCF muscles assessed by the CCFT.

1.3 Hypotheses

A paucity of literature exists regarding the preventative protocols that are in place regarding FHP and CCFE in the asymptomatic participant, It was for this reason the following null hypotheses where set to address specific objectives One, Two and Three.

1. There would be no change in DCF activation scores, isometric endurance and Neuromotor control) measured using the CCFT technique after implementation of CCFE in the asymptomatic participant.

2. There would be no change in the postural assessment values (FHP), (CV angle) after implementation of CCFE in the asymptomatic participant.

3. There would be no change in cervical range of motion after the implementation CCFE in the asymptomatic participant.

1.4 Limitations

It was assumed that the participants were willing, able and compliant with the required exercise regime at home and noted there progress appropriately in the exercise diary. Therefore there was reliance on the fact that participants were open and honest about their recorded exercise times, dates and sets of repetitions.

It was also noted that the baseline measurements for FHP and cervical range of motion are not set in the literature with regards to asymptomatic persons. Therefore, it was noted that these varied in the participant group principally as a result of their morphology (Bergmann *et al*, 1993). However as this study utilized the participants as their own controls and focused on the range of improvements noted in respect of range of motion, FHP and DCF activation scores, it is anticipated that variance would not unduly affect the outcomes of the study Mouton, 2006). It is however acknowledged that a more homogenous grouping would have facilitated ease of interpretation of the statistical aspects of this study (Brink, 2012).

1.5 Conclusion

With the focus of chiropractic treatment being to restore proper spinal biomechanics, which includes the relief of pain symptomatology, It is therefore important that the profession develop tools / guidelines for the asymptomatic population groups in order to prevent / decrease the risk of developing mechanical related neck pain and / or headache (Haldeman *et al*, 2005). Therefore postural observation, analysis and treatment should encompass chiropractic care (Haldeman, 2005; Dagenais *et al*, 2008). Thus this study measured the effect of CCFE in neck posture and range of motion in the asymptomatic participant.

Chapter Two follows this chapter outlining the literature more fully before Chapter Three presents the materials and methods utilized in this study. Then Chapter Four will present the results as well as present the discussion based on these results. Chapter Five presents the conclusions and recommendations.

Chapter Two
Literature review

Agonist: the muscle that has the primary responsibility for allowing a certain movement; a prime mover (Marieb, 2003).
Antagonist: Muscles that act in opposition to the prime mover or agonist; also allowing that movement. (Marieb, 2003).

2.1 Introduction

This chapter presents the relevant anatomical features of the neck (cervical spine). Thereafter, mechanical neck pain will be discussed in terms of epidemiology, aetiology, clinical presentation and clinical consequences. Additionally craniocervical flexion exercise (CCFEs) and their effects will be discussed along with measurements used to assess the effectiveness of CCFEs – including cervical range of motion and the craniovertabral angle (CV).

2.2 Definition of neck pain

Neck pain is the complaint of pain in the anatomical region that is bounded by the base of the occiput superiorly, the third thoracic vertebrae inferiorly (Cote *et al,* 2003) and the attachments of the trapezius muscles laterally (Moore ad Dalley, 1999; Standring, 2008). In this position, the neck is the principle connection between the head, trunk and limbs and contains many vital and necessary structures (viz. the vertebral column, related musculature, the thyroid gland, the trachea, the jugular veins, the carotid arteries) (Moore and Dalley, 1999). In particular, the vertebral arteries have been known to become irritated with cervical manipulation resulting in “drop attacks” and sometimes even cerebro-vascular accidents or stroke making these arteries very important structures amongst joint manipulative specialists such as chiropractors when considering contra-indications to cervical manipulation (Haldeman, 2002).

2.3 Anatomy

2.3.1 Vertebrae of the Cervical Spine

Contextually, the spine consists of twenty-four distinct vertebral bodies (Moore and Dalley, 1999; Magee, 2006; Standring, 2008):

- seven cervical vertebrae (the superior most vertebrae)
- twelve thoracic vertebrae (those associated with the thoracic cage)
- five lumbar vertebrae (located between the thoracic cage superiorly and the sacrum inferiorly).

The structure and function of each of the above is directly related to the anatomical and physiological demands placed on them in the region within which they are located (Vernon and Mior, 1990).

This research focuses on the cervical spine and therefore only the cervical vertebral structures will be discussed in this chapter. The cervical spine is formed by two functionally distinct, but interacting mechanisms: - the upper cervical spine contains the occiput, atlas and axis; and the lower cervical spine contains the third to seventh cervical vertebrae (Bergmann *et al*, 1993; Haldeman, 2005).

The first vertebra or the atlas, the second vertebra or the axis and seventh vertebra or vertebrae prominence are classified as atypical. This classification results from the fact that the body of the first cervical vertebra is structurally and functionally part of the second vertebra (viz. the dens or odontoid peg).The remainder of the body of the atlas becomes the anterior arch The seventh cervical vertebra is atypical as it often has features of thoracic vertebrae, which may include demi-facets for ribs articulations; change in the shape and size of the vertebral body and orientation of the facets may mimic those in the upper thoracic spine (Bogduk and Twomey, 1987; Crammer and Darby, 1995).

By contrast, the third through to the sixth cervical vertebrae are classified as typical cervical vertebrae and the bodies of the vertebral bodies are concave superiorly, convex inferiorly, and they are smaller in their antero-posterior dimension than their lateral dimension.

All cervical vertebrae are unique in that they each have a vertebral canal (Wiesel *et al*, 1992; Giles and Singer*,* 1998; Moore and Dalley, 1999; Bergmann and Peterson, 2010):

- which is large and triangular;
- transverse processes that contain transverse foramina;
- the superior facets are directed in a superoposterior direction;
- the inferior facets are directed in an inferolateral direction;
- the spinous processes of the second (although unusual) to fifth cervical vertebrae are short and bifid;
- the sixth and seventh cervical vertebrae spinous processes are usually longer and show a lesser tendency to being bifid and
- the presence of uncovertebral joints (joints of von Lushka).

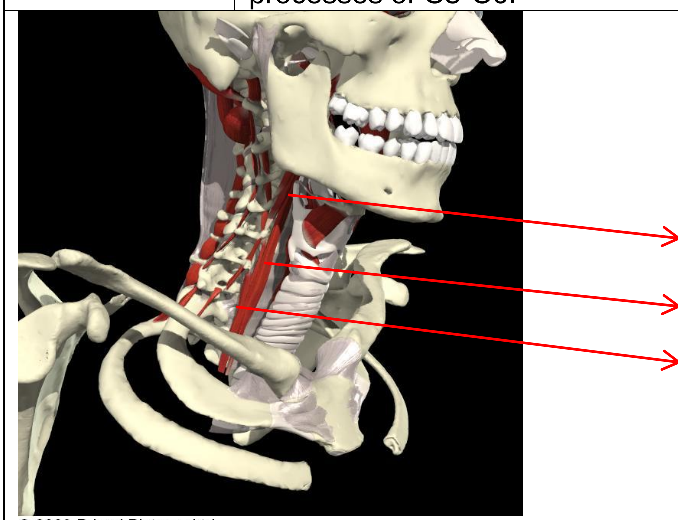
The bony structures of the cervical spine receive their innervation from the anterior or ventral rami as well as the middle and posterior branches of the posterior or dorsal rami at their corresponding level as well as from a segment above and a segment below (Crammer and Darby, 1995; Haslett *et al*, 2002; Leach, 2004). The most innervated region is usually that associated with the bony elements related to the facet joints as well as the spinous processes. It is, however, noted that all bone is covered by periosteum which is generally well innervated. Therefore, any condition that is likely to affect bone may also be a risk factor associated with neck pain (Crammer and Darby, 1995; Haslett *et al*, 2002; Leach, 2004).

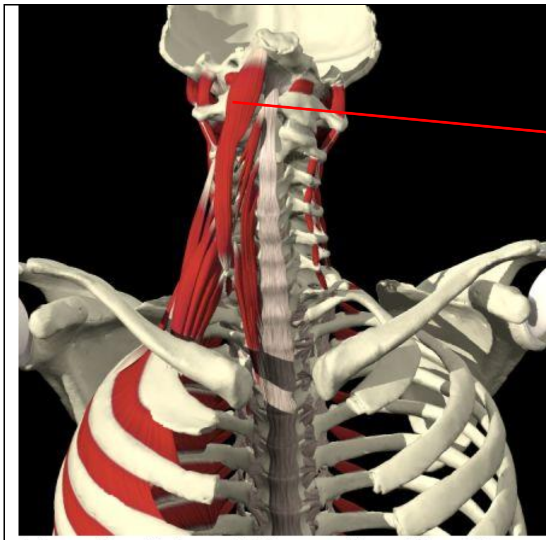
The facet orientation, the shape of the vertebrae (particularly the uncovertebral joints), ligamentous and muscular limitations of the adult cervical spine, creates or results in a mild lordosis. Lordosis is usually described as a curve with the apex at the fifth cervical vertebra and an average of approximately 34 degrees (Harrison *et al*, 1996). To better understand the role of muscles in the formation of the lordosis. The next section will cover the musculature of the cervical spine with particular emphasis on those muscles pertinent to this study.

2.3.2 Anatomical attachments of the deep cervical flexors.

The following table (Table 2.1) represents the muscles pertinent to this study.

Table 2.1 Muscle of the neck (adapted from Moore and Dalley, 1999).

	Superior attachment:	*Inferior attachment*:
Longus Colli	Anterior tubercle of C1 vertebra; bodies of C1-C3 and transverse processes of C3-C6.	Bodies of C5-T3 vertebra; transverse processes of C3-C5.
 © 2003 Primal Pictures Ltd. Figure 2.1:		Longus Colli (superior oblique) Longus Colli (verticularis) Longus Colli (inferior oblique)
Longus Capitus	Basilar part of occipital bone	Anterior tubercles of C3-C6 transverse processes.

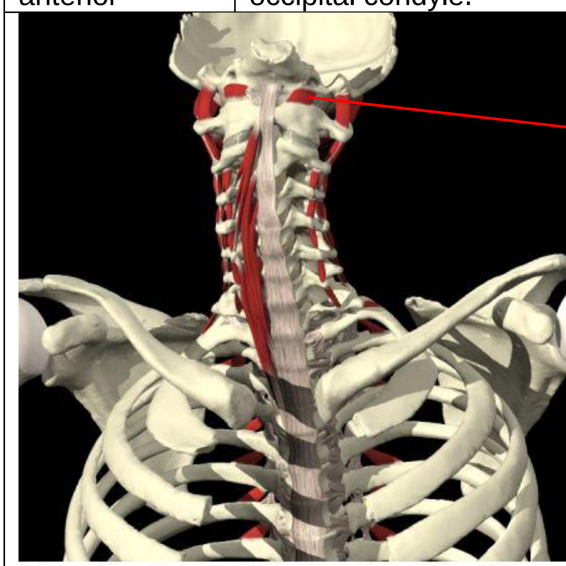


Longus Capitus

Interactive Spine - Chiropractic edition ©
2001 Primal Pictures Ltd

Figure 2.2

Rectus capitus anterior	Base of skull, just anterior to occipital condyle.	Anterior surface of lateral mass of C1 vertebra.



Rectus capitus anterior

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Figure 2.3

Rectus capitus lateralis	Jugular process of occipital bone	Transverse process of C1 vertebrae

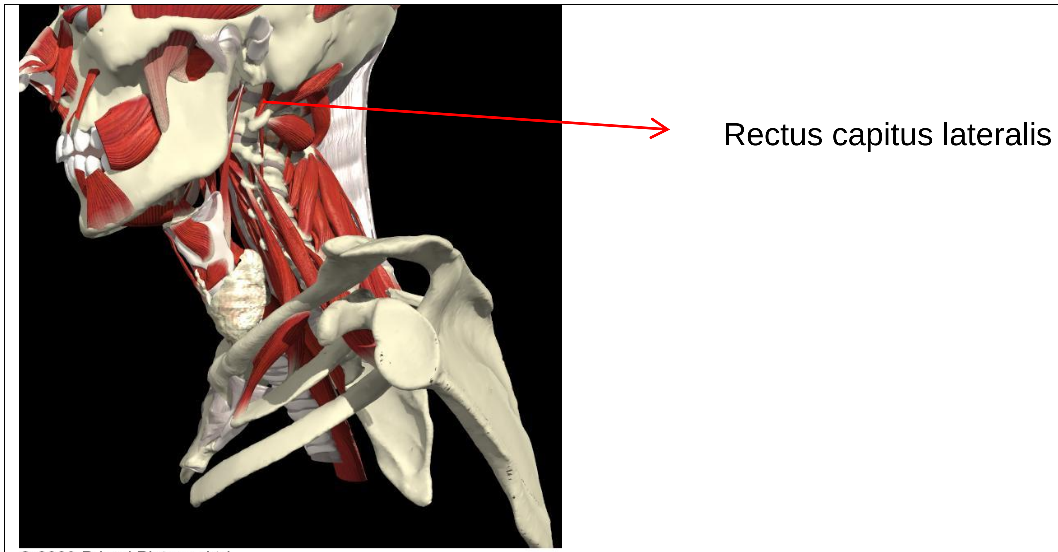


Figure 2.4

CCFE is a clinical test designed to isolate the upper cervical spine in flexion hence not including flexion of the mid and lower cervical spine. This is based on the anatomical interrelated function of the deep muscles to support and stabilize the cervical spine whilst also producing slight flattening of the cervical lordosis (Chiu *et al*, 2005).

2.4 Deep Cervical Flexors (DCF) and Cervical Biomechanics

The DCF is composed of longus capitus, longus colli, rectus capitus and rectus lateralis (Moore and Dalley, 1999; Standring, 2008). These muscles are of great importance where stabilization of the cervical spine is concerned (Jull *et al*, 2008). The longus colli, longus capitus and rectus capitus anterior provide support (Falla *et al*, 2004) anteriorly countering the accentuation of the lordotic angle induced by the extensor muscles (levator scapulae and the splenius capitus muscles) (Liebenson, 2007).

This antagonistic relationship between these muscles appears to play a role in stabilizing the upper cervical spine during movement of the neck (Falla *et al*, 2004); by slightly flattening the cervical lordosis (not enough to straighten the curve), to open the posterior facet joints slightly allowing the global and more superficial muscles (e.g. trapezius muscle) to move the cervical spine without facet joint compromise or jamming (Jull, 2000). However changes in muscle length as a result of trauma, pathomechanics or repetitive strain injury can result in shortened hypertonic cervical extensors and weak hypotonic DCF's, which is characterized by forward head posture (FHP) (Foreman and Croft, 1995; Norkin and Levangie, 1992; Lau *et al*, 2010). This FHP is thought to lead to abnormal biomechanical strain, zygopophyseal joint aberration, and limited cervical range of motion, mechanical neck pain and headache (Norkin and Levangie, 1992; Bergmann *et al*, 1993; Gracovetsky, 1988; Kendall *et al*, 2005).

2.5 Etiology of muscle imbalance

Potential factors which may increase the risk to developing neck pain are classified as accidental (Foreman and Croft, 1995); structural (Terry *et al,* 1985; Sunder, 2006), lifestyle (Kirkaldy-Willis and Burton, 1992) and / or metabolic (Haslett *et al*, 2002; Wulan *et al,* 2010) factors.

2.5.1 Accidents and injury

Accidents and injuries can result in acute or chronic musculoskeletal pain and discomfort (Foreman and Croft, 1995), which forces the body to adapt in compensatory ways to avoid pain. If left long enough, this results in faulty posture and abnormal spinal curves (Norkin and Levangie, 1992). Whiplash (acceleration-deceleration syndrome), would be one such example) (Foreman and Croft, 1995). Conversely, pre-existing faulty posture or abnormal spinal curves can increase the risk of having an accident / injury or worsen an injury from such (Liebenson, 2007). In the latter context, an example where an injury to the ankle forces a patient to bear most of their weight on the unaffected ankle, to avoid the injured ankle. This prolonged change in position and function impacts posture and predispose to changes in biomechanics and thus result in pain at locations other than the site of injury (Brantingham *et al*, 2009)

2.5.2 Pain of non-injury origin

Haughie *et al*, (1995); Harrison (1996); Marcus (1999) and Abdulwahab (2000) all suggest that pain related to postural deviation is a common clinical phenomena. This is confirmed by Borestein, Wiesel and Boden (2004), who indicated that there are four key risk factors that predispose and interlink with another. These include a history of joint pain, posture, range of motion and stability in the given joint and joints of the kinematic chain under investigation (Brantingham *et al*, 2009).

2.5.3 Connective tissue and muscle dysfunction

Muscle balance refers to the relationship between the strength (Harman, 1994; Coppock 1958; Holloway, 1994) and length of opposing muscles or opposing muscle groups (Kelly, 1949; Phelps *et al*, 1932; Reiter and Cato, 1970; Wells, 1963; Zatsiorsky, 1995). Muscle imbalance may develop as a result of facilitation of antagonistic muscles with inhibition of the agonist muscles resulting in muscular aberration and muscle imbalance, this leads to impaired movement patterns (Janda, 1983). This abnormal pattern results in over activation of specific muscles and inhibition of others (Liebenson, 2007). In this context, the imbalances in muscle length and strength and ligamentous length has been a noted cause of asymmetrical stresses on joint structures, which have been linked to abnormal posture (e.g. FHP) (Anderson, 1998; Phelps and Kiphuth, 1932).

Therefore when looking at FHP, it is important to address the outcome of adaptive muscles or ligaments shortening (Bergmann and Peterson, 2002; Robergs and Rodgers, 1997), as muscle balance is thought to be a necessary and important dynamic factor in postural control (Phelps and Kiphuth, 1932; Kelly, 1949; Wells, 1963; Reiter and Cato, 1970; Zatsiorsky, 1995). In addition to this consideration must also be given to the fact that muscles have an inherent ability to apply a force through articulations / joints that sustain and can result in asymmetrical positioning (Kelly, 1949; Phelps *et al,* 1932; Reiter and Cato, 1970; Brandt, Buchele and Kracyck, 1986; Kendall *et al,* 1993; Bloomfield, 1994; Holloway, 1994; Zatsiorsky, 1995)

Thus, Kelly (1949); Janda (1983); Kendall *et al,* (1993) and Bloomfield *et al,* (1994) assert that the resting muscle length influences postural alignment and that adaptive muscle shortening is believed to cause postural deterioration.

2.5.4 Neural system and posture

Hrysomallis and Goodman (2001), suggest that the effect of the nervous system on posture is largely ignored. This could be considered a drawback of dynamic assessment strategies (e.g. muscular) and their related interventions in patients with postural problems. This is because postural stability in dynamic situations is maintained by both a feed-forward control and rapid feedback corrections of the nervous system (Roberts, 1978; Houk, 1979; Ghez, 1991). This is supported when reviewing posture as a result of muscle imbalance, where research seems to ignore the possibility that a muscle’s tone and length have a largely dependent interaction with the nervous system (Roberts, 1978). This is incongruous, when all muscles, their tendons and ligaments contain a variety of receptors (viz. Wyke receptors) (Leach, 1996; Cramer and Darby, 1995; Standring, 2012).

These Wyke receptors sense changes in tension in the ligament or tendon and assess muscle length, measuring acceleration / deceleration between different bony structures (Cramer and Darby, 1995; Hillermann, 2003; Hillermann *et al,* 2005). This information travels to all central nervous system levels (Tortora and Derrickson, 2011) to elicit a response and reaction (Guyton and Hall, 1997). This integrated response to sensory information informs the reflex response and is thus the basis of postural control (Ghez, 1991).

Thus from a neurological system perspective, significant deviations from normal posture are thought to adversely influence muscle efficiency and predispose to or be predisposed by musculoskeletal or neurological pathological conditions (Bloomfield, 1994; Novak and Mackinnon, 1997; Hrysomallis and Goodman, 2001).

2.5.5 Nutritional factors

Postural alignment of the body, particularly in pediatric and geriatric patients is dependent on proper nutrition (Haslett *et al*, 2002; Kendall, 2005). A weakening of the skeletal system over time will lead to bony deformation within the skeletal structure (Haslett *et al,* 1999; Strachan, Sharma and Hunter, 2008), which results in altered posture with changes to joint stability and the longer term consequences of pain (Borestein *et al*, 1996).

Nutrition may conversely also be linked to excess weight (overweight, obese or morbidly obese patients). Weight changes, change the body’s centre of gravity and therefore the spine is required to load in a manner that is different from the normal position resulting in compensatory actions. As the primary global displacement responses are engrained in the muscle function and neurological responses, the combined effects often lead to painful clinical sequelae (Shirazi *et al*, 2004).

2.5.6 Age

Age reflects the decisions made throughout life, In essence, the developing child has a much greater mobility and flexibility than the adult leading to slightly different postural alignment (Kendall *et al*, 2005). In older adults one of the most noted postural transformations is more pronounced FHP, accentuated thoracic curve and loss of the normal lumbar lordosis (Bergmann *et al,* 2005; Haldeman, 2005; Kendall *et al,* 2005; Jull *et al,* 2008).

2.6 Psychological factors

Weethalle (2010) indicated that in order for a patient to maintain a good posture, they are required to be psychologically stable and require continuous nourishment for the mind, body and spirit.

2.6.1 Environmental factors

2.6.1.1 Work related:

Borestein *et al,* 2004, indicated that there are four key risk factors that are linked in the development of postural changes; these include a history of pain, posture, range of motion and stability of the region. These factors are influenced by several work activities, such as bending and twisting (Wai *et al,* 2010), carrying and pulling (Pope *et al,* 2002; Roffey *et al,* 2010), lifting or handling goods (Hoogendoorn *et al,* 2000; Roffey *et al,* 2010), pushing (Pope *et al,* 2002; Roffey *et al,* 2010), tiring or repetitive positions (Page et al, 2010; Roffey *et al,* 2010; Plouvier *et al,* 2011) and whole body vibration (Chung *et al*, 2005).

Thus it could be stated that working postures play a significant role in changing one or more of these factors thereby facilitating a negative effect on posture (Szeto, Straker and O'Suillivan, 2005; Ho, Tai and Tung, 2008). This results in and from uneven load distribution across one or more joint structures, with the result that there is increased likelihood of 'wear and tear' / degeneration which will eventually generate pain (Adams, Mannion and Dolan, 1999).

An example of this is portrayed by the National Institute for Occupational Safety and Health (NIOSH,1997), which refers to a group of conditions that involve the tendons and their muscles as well as supporting soft tissue as work related musculoskeletal disorders (WRMSDs). In the long term these conditions although minor and of repetitive nature to begin with, generally become chronic, causing postural changes in workers with the sequelae of pain and discomfort. Thus, Hagberg *et al,* (1995) consider WRMSDs as a group of diseases subdivided into clinically well defined disorders (e.g. those of long standing duration) and less well defined disorders (e.g. early pathogenesis of repetitive strain injuries).

Based on the compromise of activity and therefore ability to work, as a result of these conditions, the Governing Body of the International Labour Office (2005) has included WRMSDs in several national lists of occupational diseases. This not only signifies the importance of these conditions in the workplace, but also indicates the extent to which ergonomic factors influence posture.

As can be seen from the foregoing discussion on the various factors that may cause postural distortion, there are many factors to consider. These causative factors all play a role in the development of this muscular imbalance through changes in their viscoelastic properties and contractile elements (Norkin and Levangie, 1992). According to Page *et al*, (2010), these changes occur within the DCF muscles and results in patients presenting with FHP (Jull, 2008). Additionally these patients may also show signs of prominent sternocleidomastoid and anterior scalene muscles which are compensatory bodily responses in patients with FHP (Falla, 2007). Thus during observation of the supine patient, when asked to tuck their chin into their chest, the head tends to move forward instead of into normal neck flexion (Page *et al*, 2010).

The above concurs with Janda (1983), who indicated that muscular imbalances can present as functional and / or structural aberrations. The functional aberration is usually characterized by chronic joint dysfunction (Haldeman, 2005; Jull *et al,* 2008) and the structural aberration being manifest with acute injury such as acute disc herniation.

These changes in posture and their clinical sequelae (viz. neck pain) (Haldeman 2005; Jull *et al,* 2008) are substantial contributors to medical consumption (Borghouts *et al,* 1996; Cote *et al,* 1998). These expenses are related directly to absenteeism from work (Borghouts *et al,* 1996); and disability in the working-age population (Cote *et al,* 1998). Disability accounted for 50% of the total costs related to neck pain in the Netherlands (Borghouts *et al,* 1996). To complicate this picture, Linton (2000) stated that there are further difficulties in successfully treating long-term back and neck problems. He showed that the as chronicity of neck pain increased so did its reoccurrence. Therefore it is important and of significant clinical interest to determine specific risk factors and prevent the neck pain cycle from beginning / or before it starts (Jull *et al*, 2008).

Thus the next section will deal with possible methods by which neck pain as a result of postural changes could be prevented from starting and therefore avoiding both the immediate and long term sequelae of the neck pain cycle starting.

2.7 Structural and functional approaches to muscle imbalance

Based on the theoretical constructs proposed by Janda (1983), there are two approaches to rectifying the functional and / or structural aberrations the present with muscular imbalances. The evaluation of the patient in the "structural approach" focuses on the anatomical and biomechanical assessment of the region utilizing static imaging techniques such as MRI (magnetic resonance imaging), CT (Computed tomography) scans and / or X-rays. This approach is indeed useful in the diagnosis and treatment of structural aberrations effecting particular areas, particularly the neck. However it must be considered that when addressing a patient's structural changes, it usually implies that the patient's muscles, ligaments, bones and joints have already undergone changes that may or may not be reversible (Norkin and Levangie, 1992). Thus, this means that the treatment for this could involve the combination of one or more of the following:

rehabilitation (Liebenson, 2007; Janda, 1983), manual therapies (Bergman et al 1993; Byfield, 2010; Bergman and Peterson, 2011), immobilization (Haldeman, 2005) and in some cases surgery (Liebenson, 2007).

By contrast, there are also those patient cases that may present with no apparent diagnosis after imaging (viz. no structural changes). This suggests a more functional aberration as a cause if the patient's neck pain (Page *et al,* 2010), This implies that the patient has presented in an earlier stage of the pathogenesis and would require less extensive and therefore also less expensive intervention strategies (e.g. featuring only changes in movement patterns (Falla, 2007). In this context the reversibility of the tissue changes that are manifested in the patient are usually greater and therefore there is greater functional ability (Falla, 2007).

Therefore the practitioner is required to be able to link: the patient presentation, the assessment, the relevant systems involved (e.g. muscular, skeletal and / or the neurological systems); visualize their collective input and resultant functional or structural aberration (Page *et al*, 2010) and then determine the stage of the pathogenesis and apply the most appropriate intervention strategy (Haldeman et al, 2008). As a result, many rehabilitation protocols and exercises are aimed at creating the ideal posture (Liebenson, 2007).

This is reflected in the study by Pearson and Walmsely (1995), who described their findings in terms of "resting posture" with a group of 30 patients who performed three sets of 10 repetitions of neck retraction exercises. It was found that after performing the second set of exercises, that the patients neutral resting posture demonstrated a statistically significant (p=<0.05) reduction in FHP that averaged approximately 4mm.

Similarly, Harrison, Jackson and Troyanovich (1994), in their retrospective study, found an overall improvement in the degree of the cervical lordosis (13.2º) and a 9.8mm reduction in FHP following a regimen of 12-weeks of maximum tolerance cervical extension traction. These results were compared to a control group that received no intervention over a similar 12-week period.

2.8 Relationship of postural changes to the DCF muscles of the neck

Joint dysfunction, cervical spine motion aberration and deep cervical flexor impairment [viz. longus colli and longus capitus muscles] are synonymous with long term neck pain and its sequelae (Haldeman, 2005; Jull *et al,* 2008). This is based on current research that indicates that there is no spontaneous improvement in DCF muscle function until specific exercises are prescribed (Jull *et al*, 2008). Therefore a limited prognosis for improvement exists for patients with DCF muscle dysfunction, whereas a greater likelihood for clinical deterioration is possible with its resultant sequelae exists (Bergmann et al 2005; Haldeman, 2005; Kendall *et al*, 2005; Jull *et al*, 2008).

Even though many patients present with FHP as a result of DCF muscle dysfunction, there are specific and targeted exercises that can be done to avoid DCF dysfunction (Jull and Sterling, 2008). The most specific of these is an exercise protocol referred to as craniocervical flexion exercises (CCFEs), that specifically target the DCF muscles (longus colli and longus capitus muscles of the DCF compartment) (Jull *et al,* 2002). These exercises aim to restore the isometric endurance and appropriate neuromotor control of the DCF muscles.

According to Jull and Sterling (2008), it has been established that the CCFE’s are effective at improving DCF isometric endurance and neuromotor control and that these results are reproducible. This adds to the previous work of Jull *et al,* (2002) who indicated that CCFE’s are an effective tool used in the treatment of cervicogenic headache.
However, the possible role that CCFE’s could assist with cervical posture in the asymptomatic participant, in order to prevent postural aberrations with the resultant sequelae being avoided, requires further investigation.

This is significant in that should CCFE’s be able to assist with correcting posture in asymptomatic people, it would lay the groundwork for future research in developing a positive predictive value for CCFE’s in terms of their ability to protect patients from developing mechanical neck pain, joint dysfunction and related biomechanical disorders in later life (Jull *et al*, 2002).

2.9 Craniocervical flexion exercise (CCFE)

CCFE is a low load exercise developed by Jull *et al,* 2002 to activate the DCF muscles, particularly the longus capitus muscle in synergy with longus colli muscle (Jull *et al* 2008). The exercise is used to enhance the individual’s ability to slowly perform and hold the chin tuck movement. This is a precise upper cervical flexion action which is designed to limit movement at the mid and lower cervical spine. It is based on the interdependent relationship of these deep cervical muscles to stabilize and support the neck during activity and at rest and also to slightly flatten the cervical lordosis hence improving biomechanical loading patterns (Jull *et al*, 1999; Liebenson, 2007).

To perform this exercise, the participant is usually positioned in crook half lying posture with an unsupported neutral neck position. The participant is then instructed to perform a head nodding action to target sequentially five 2mmHg progressive pressure increases from the baseline of 22mmHg to a maximum of 30mmHg as well as to hold the position steady in a low load endurance test. Once correct technique has been established the participant is expected to progress through the five stages of craniocervical flexion incrementally from stage one to five, only moving to the next stage once able to perform 10 repetitions of 10 second holds per stage with correct form (Jull *et al*, 2008).

2.9.1 CCFT staging process

Stage1 (CCFT)	22mmHg	perform10 repetitions holding each repetition for 10 seconds then move to next stage
Stage2 (CCFT)	24mmHg	10 repetitions for 10 seconds each
Stage3 (CCFT)	26mmHg	10 repetitions for 10 seconds each
Stage4 (CCFT)	28mmHg	10 repetitions for 10 seconds each
Stage5 (CCFT)	30mmHg	represents improved neuromotor control &isometric endurance of DCF muscles

Table 2.2

Once able to perform all stages efficiently one can assume that normal DCF function has been achieved (Jull *et al,* 2008).

In a study to quantify the 5 incremental stages of CCFEs, a demonstrated average of 24.9% was used to achieve the first target of 22 mmHg. Followed by linear increments of up to 80% to achieve the last stage of the test at 30mmhg (Falla *et al,* 2003). Some patients did manage higher scores although compensatory muscle actions were observed such as lower and mid neck flexion as well as retraction of the cervical spine. As a result of this the test has been proven more suitable to train fine neuromotor control and muscular endurance of the deep cervical flexors (Jull *et al*, 2008).

According to Jull et al, (2008) the CCFE protocol will take an average four weeks to progress from stage 1 (22 mmHg) to stage 5 (30 mmHg) hence suggesting substantial improvement of the deep cervical flexors and improved local motor control and endurance. This then suggests optimum DCF activation with sufficient support of the cervical spine and lordosis.

2.10 Measurement of improved DCF function

CCFEs have been found to correct muscle aberrations by improving local neuromotor control of the DCF's, which may restore normal cervical spine biomechanics and decrease the possible development or recurrence of head and neck pain (Bergmann *et al*, 1993). Correcting cervical posture with CCFEs in patients has shown to decrease symptomatology; however a paucity of literature on the role that CCFE could play on cervical posture in the asymptomatic patient exists. Therefore, this research investigated this construct and utilized the following measurement tools to determine participant improvement over time:

- Cervical posture will be measured by use of the craniovertabral angle (CV) and
- Cervical range of motion.

These "biomechanical" measurements such the CV angle and, cervical range of motion are tools used in the assessment of functional aberrations (Janda, 1998).

2.11 Forward head posture and the craniovertabral angle (CV)

The CV angle lies between a horizontal line running through C7 spinous process and a line connecting the C7 spinous process and the tragus of the ear. The smaller this angle, the greater the forward head posture, indicating a shift of the head anteriorly in the sagittal plane. The larger the angle measured, the more representative the posture of being "ideal" indicating normal head and neck alignment (Ho Ting Yip *et al*, 2007).

Figure 2.5

The craniovertebral (CV) angle.

(Ho Ting Yip et al, 2007)

Currently, no standard or “ideal” CV angle ranges exist. However a study conducted by (Ho Ting Yip *et al*, 2007) found that the CV angle in patients that presented with neck pain was 43.9º as opposed to a mean average of 50.9º in the control group. Similar conclusions were drawn in a study (n=53) conducted by (Lau and Lam *et al*, 2008), which found that subjects with neck pain had considerably smaller craniovertebral angles than asymptomatic subjects. These researchers also recommended routine measurement of the CV angle to further monitor patients presenting with or without neck pain and dysfunction.

The primary function of neck muscles is to maintain postural balance of the neck and head, thus making isometric testing an appropriate method to evaluate neck strength. Furthermore few studies exist on neck strength and of training methods aimed at improving this strength (Ylinen and Rezasoltani *et al,* 1999). Measuring the CV angle thus helps to ensure and objectify improvement in the clinical setting.

2.12 Cervical range of motion

Cervical range of motion includes four basic movements of the head alone, and the degree of active movement is measured to determine any deviation from the normal range of motion (Lewit, 1991). These include (Lewit, 1991):

1) Flexion: 40º
2) Extension: 75º
3) Lateral flexion: 35º
4) Rotation: 90º

It should however be noted that the above figures are only averages and a study that reviewed cervical range of motion testing in 130 articles found the following cervical ranges plausible: flexion: 43º to 73º, extension: 33º to 77º, rotation: 60º to 86º and lateral flexion: 41º to 54º. Gender comparison was observed and noted to be 2º-4º degree's greater in females than in males with and average decrease of 4º in cervical range of motion every four decades (Tamara and Zeevi, 2008). This concurs with Liebenson (2007), who noted marked reductions in cervical range of motion in the elderly due to degenerative changes of the cervical facet joints.

As a result this form of linear range of motion measurement does have its disadvantages as these do not consider human variance such as gender, age group and human morphology (Falla *et al*, 2004).

As a result of these variances, cervical range of motion has not been the only measurement in this study, but has been combined with the CV angle in order to determine the changes due to the CCFEs.

2.13 Conclusion

With FHP (commonly measured using the craniovertebral (CV) angle) being a common postural abnormality as a result of weak DCF musculature and in people with mechanical neck pain (Duani, 2010); an increase in the CV angle (Lau *et al*, 2010) would be the most appropriate measure to determine change as a result of CCFE's. This test of cervical postural measurement becomes clinically relevant when trying to measure DCF activation and its effect on maintaining normal cervical biomechanics and as a consequence, cervical posture and regional range of motion (Jull *et al*, 2008). Therefore by establishing the effect of CCFE's on the CV angle and cervical range of motion in asymptomatic participants, this may help establish definitive guidelines with regard to the prevention of mechanical related neck pain and dysfunction and also help establish research for others to elaborate on.

Therefore, this research will help establish if CCFE's effects on cervical biomechanics can play a role in establishing ideal cervical posture in asymptomatic participants and will allow for further research into the prevention of the development of cervical degenerative pathology using ideal cervical posture as a prophylactic tool.

Chapter Three
Methodology

3.1 Introduction

This chapter aims to measure the effect of Craniocervical Flexion Exercise (CCFE) on cervical posture by use of the craniovertabral angle (CV) and cervical range of motion in asymptomatic participants. This chapter offers a description of the sample being studied, the outcome measures and statistical analysis, with the aim to fulfill the objectives as set out in Chapter One.

3.2 Study design and ethical considerations

This study was a quantitative pre/post intervention study utilizing a single group of 45 asymptomatic participants. The study was approved by the Faculty of Health Sciences Research and Ethics Committee at the Durban University of Technology (DUT) and adheres with the Helsinki Declaration of 1964 (Johnson, 2005). The Ethics clearance certificate number is: IREC 006/12.

3.2.2 Study location

The study was conducted at the DUT Chiropractic Day Clinic.

3.2.3 Participant recruitment

Participants in this research were sourced via advertisements in local shopping centers, gyms and sports clubs and fliers were posted in and around the DUT campus (Appendix A).

Prior to the initial appointment, all candidates underwent a telephonic screening for the purposes of exclusion. The following questions were asked:

Table 3.1		
Telephonic questions: Question Number:		Required answers
1	Do you suffer with neck pain?	No
2	Do you suffer with headaches?	No
3	Have you ever received a spinal surgical procedure specific to the neck?	No
4	Have you taken part in any research in the last two weeks?	No
5	Are you between the ages of 18-45 years of age ?	Yes

3.2.4 Clinical assessments

If successful and following the initial telephonic interview, the participant visited the DUT Chiropractic Day Clinic. These participants first received a Letter of Information and Informed Consent Form (Appendix B) and underwent a complete case history (Appendix C), physical examination (Appendix D) and cervical regional examination (Appendix E).

3.3 Subject allocation and inclusion criteria

3.3.1 Inclusion criteria

Participants were included in this study if they fulfilled the following criteria:

1. All participants had to be between the ages of 18 and 45 years of age. This was in order to avoid the need for including participants that could not give consent of their own free will as well as to avoid / limit participants that are not yet fully skeletally mature (Yochum and Rowe, 1996; Marchiori, 1999). The upper age limit was to avoid age related degeneration (Yochum and Rowe, 1996; Marchiori, 1999) and effects of long term postural and mechanical derangement (Schafer and Faye, (1989); Haldeman, (2005) in participants, which could have been resistant

to exercise protocols and their effect as a result of joint compromise (Kendall *et al*, 1993).

2. Participants had to be free from cervical pain, cervicogenic headaches and temporomandibular joint syndromes. This was ensured using DUT protocol including case history, physical examination and cervical regional examination (Foreman and Croft, 1995).

3. Participants were required to be unable to perform CCFE's effectively through all 5 ranges (e.g.: Unable to hold the CCFE chin tuck movement for 10 seconds with correct technique between 20 and 30 mmHg). If they were unable to perform CCFE's it indicated that they had a weak DCF muscles (Jull *et al*, 2008).

3.3.2 Exclusion criteria

1. Participants were excluded if they were younger than 18 or older than 45 years of age.

2. Participants were excluded if they suffered with cervical pain, cervicogenic headache or temporomandibular joint syndromes.

3. Participants were excluded if able to perform CCFE correctly through all 5 ranges (e.g.: able to hold the CCFE chin tuck movement for 10 seconds with correct technique between 20 and 30 mmHg). If they were able to perform CCFE's it indicated that they had sufficient neuromotor control of the DCF muscles (Jull et al, 2008).

3.3.3 Allocation

After having met the inclusion criteria 45 asymptomatic participants were included into one group and baseline measurements were taken.

3.4 Procedure

On arrival, at the initial consultation, each participant received a Letter of Information and Informed Consent Form (Appendix B) giving a detailed explanation of what the research programme entailed and what would be required of them. The letter also informed the participants that they were free to withdraw at any time. After the participant had finished reading the letter and had asked any questions, he/she was asked to sign the Letter of Information and Informed Consent Form if he/she agreed to participate in the study. The participant then had a case history (Appendix C), physical examination (Appendix D) and cervical regional examination (Appendix E) performed to determine if they met the inclusion and exclusion criteria.

Male participants were asked to remove their shirts and female participants asked to wear thin stringed vests or bikini tops in order to fully observe the region of concern (viz. cervical spine and head).
Participants were required to be asymptomatic with regards to pain at the first consultation. Participants were educated and observed with regards to their performance of the CCFE, in order to ensure correct technique at the first consultation. Participants were not permitted to progress in the research process until the correct technique was confirmed.

3.5 Interventions

Participants were placed in the crook half lying position. Isometric endurance and neuromotor control of the DCF muscles was measured by use of the bio–feedback pressure unit (Chattanooga Group Inc., 2735 Kanasita Dr, Hixson, TN 37343-4091). The participant was staged using the bio-feedback pressure unit. If they were unable to correctly perform the required activities through the five stages of the procedure, it was concluded that he/she had impaired DCF neuromotor control and isometric endurance and the participant was included into the study.

Following this, baseline CV angle measurements were taken using the Smart Tool Angle Finder (OKC plant 4041 N, Santa Fe Oklahoma City, OK 73118, USA) with the participant in both the seated and standing positions, these measurements are taken when viewing the participant from a lateral position.

Additionally, the participant's cervical range of motion was measured using the cervical range of motion goniometer (3600 Labore Road, suite 6, ST Paul, MN 55110-41144). Measurements included: flexion, extension, and lateral flexion and rotation movements.

Participants were then instructed on the home exercise protocol required of them which included three sets of 10 chin tucks daily, each repetition was to be held for 10 seconds (Jull *et al*, 2008).

To monitor symptoms, participants were also given headache diaries, so that they were able to record individual progress or failure to follow the home exercise protocol. This diary also served to monitor progress and frequency of the home protocol requirements.

Table 3.2 : Summary of visits

Week	Visit	Requirements and measurements
1	1	Participant assessment Baseline readings – CCFE evaluation, CV, CROM Exercise overview and teaching
	2	Exercise verification
2	3	Exercise verification
	4	Exercise verification
3	5	Final readings – CCFE evaluation, CV, CROM

3.6 Measurement tools

3.6.1 Smart tool angle finder

The objective measuring tools for the study were the Smart Tool Angle Finder, (OKC plant 4041 N, Santa Fe Oklahoma City, OK 73118, USA), the bio-pressure feedback unit (Stabilizer; Chattanooga Group Inc., Hixon, TN), and the cervical range of motion goniometer (3600 Labore Road, suite 6, ST Paul, MN 55110-41144).

The Smart Tool Angle Finder was found to be a reliable measuring tool for the craniovertabral angle in a study (n=53) carried out by Lau et al, 2008. Each participants C7 spinous process and ipsilateral tragus of the ear were clearly marked using a coloured pen. The tool was then placed crossing these two points and the digital measurement was taken. This was performed with the participant in the standing and seated positions and the measurement taken from each of their right and left lateral sides. To ensure accuracy and non-bias the measurement was taken twice per session, once seated and once standing at the first consultation and once seated and once standing at the last consultation, with the unit pressed firmly against the allocated markers.

3.6.2 Craniocervical flexion exercise

The efficiency of the Craniocervical Flexion Exercise (CCFE) was established in a study done by O'Leary *et al*, 2007, where comparative effectiveness of CCFE and general neck flexion was measured. It was established that although neck flexion did activate the deep cervical flexors, CCFE targets the longus capitus, longus colli [superior portion] and rectus capitus anterior muscles more specifically whilst general neck flexion also recruited the superficial flexors such as sternocleidomastoid and scalene anterior muscles.

1.6.3 Cervical range of motion goniometer

Active cervical range of motion (CROM) was measured by use of the cervical range of motion goniometer (3600 Labore Road, suite 6, St Paul, MN 55110-41144). This is a measuring device that was able to provide the degree of active range of motion specific to the cervical spine and was reproducible. The ranges of motion were (Moore and Dalley, 1999):

- Flexion: movement of the cervical spine around the x- axis or sagittal plane.
- Extension: movement of the cervical spine around the z- axis or coronal plane.
- Rotation: movement of the cervical spine around the y-axis or transverse plane.

The goniometer has been proven a reliable instrument for measuring cervical range of motion (Ferandez- de- las- Penas *et al*, 2007).

3.7 Confidentiality

All data was coded to maintain patient confidentiality and anonymity. Data was shared with interested patients on request and is available via the Chiropractic Department, and in a mini dissertation in the DUT library. Research data is also required to be stored in the patient files in the Chiropractic Day Clinic for a period of fifteen years. There after the research papers within the participant files is required to be shredded.

3.8 Statistical analysis

This is a pre/post intervention study consisting of 1 group, where objective measurements will be taken. Results will be analyzed using the latest version of SPSS (SPSS Inc., Chicago, Illinois, USA). A p value < 0.05 will be considered as statistically significant (Hammond, 2011).

Chapter Four
Results and Discussion

4.1 Introduction and Data

The demographic data as well as the data obtained from the objective measures (Smart Tool Angle Finder and cervical range of motion) which were statistically significant will be presented in this chapter.

4.1.1 Primary data

The primary outcomes measures in this study considered of the Smart Tool Angle Finder reading for the craniovertebral angle and the cervical range of motion device measures for the movements of flexion, extension, lateral flexion and rotation of the head and neck.

4.1.2 Secondary data

Secondary data included measures of the participant's demographic data (including age, gender, ethnicity and body mass index (BMI).

4.2 Abbreviation particular to Chapter Four

BMI	Body mass index
CV angle	Craniovertebral angle
CCFE	Craniocervical flexion exercise
Ext	Extension
Flx	Flexion
Lat flx L	Lateral flexion left
Lat flx R	Lateral flexion right
MVA	Motor vehicle accident
Mean	Average
N	No. of participants
p	*p*-value
Rot	Rotation
SCM	Sternocleidomastoid
Seat	Seated
Stand	Standing

4.3 Consort diagram

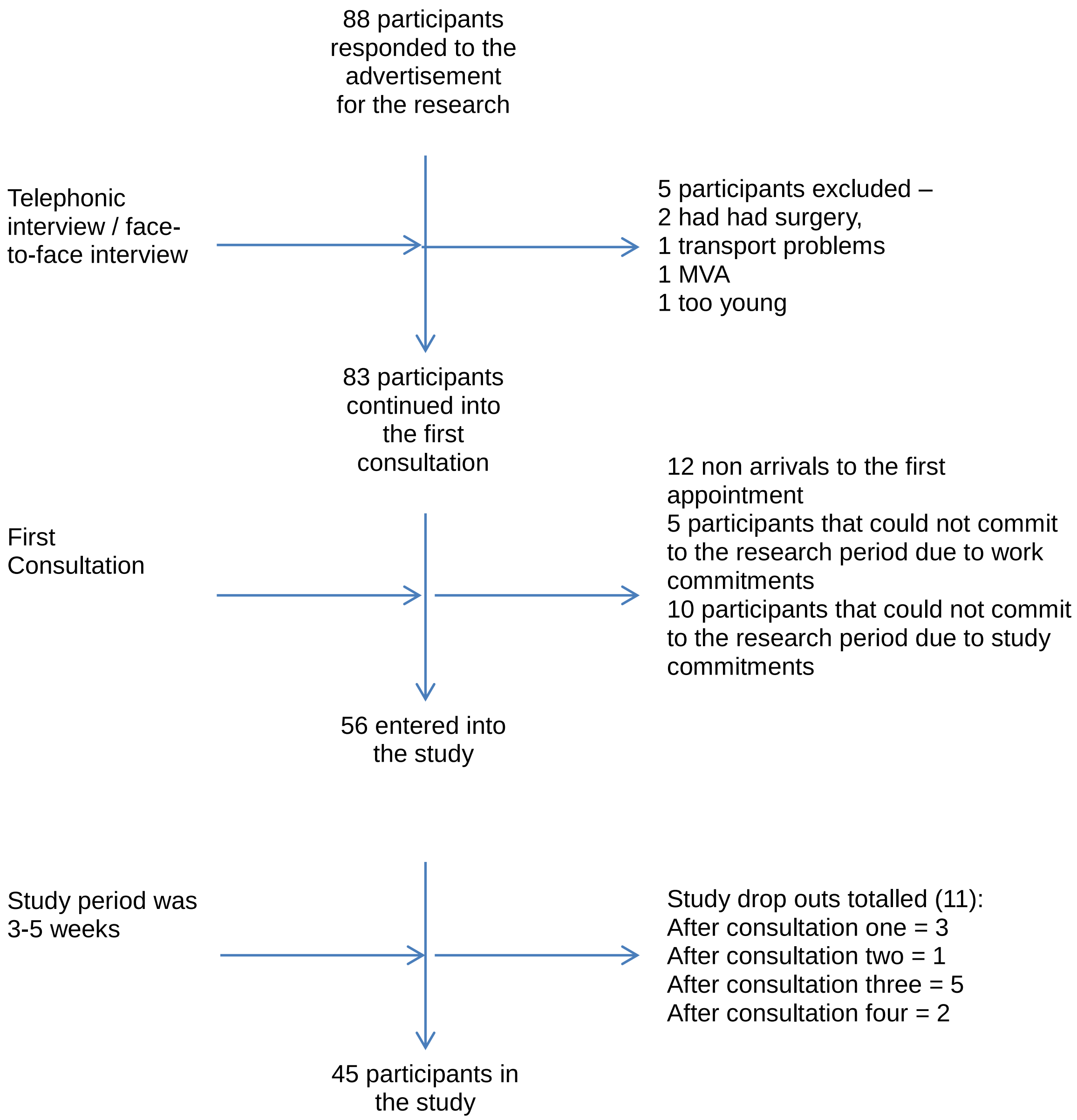


Figure 4.0 Consort diagram

4.4 Demographic data

Forty five asymptomatic participants were enrolled into the study into one group (n=45). These participants were recruited into the study only if they were unable to perform the craniocervical flexion exercises (CCFEs) through all five stages, at the initial consultation.

Eighteen males (n=18) and twenty-seven females (n=27) where enrolled into the study, of these twenty-nine were White (n=29), nine were Indian (n=9) and seven were Black (n=7).

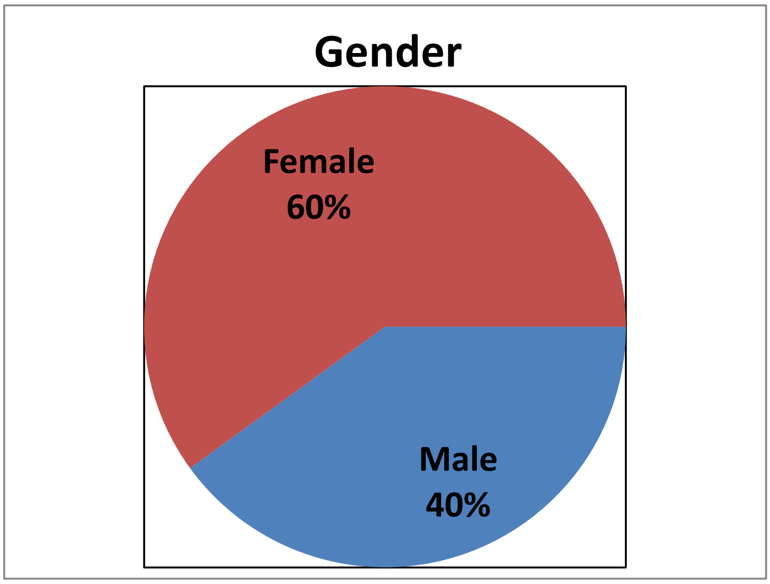


Figure 4.1 Gender comparison (n=45)

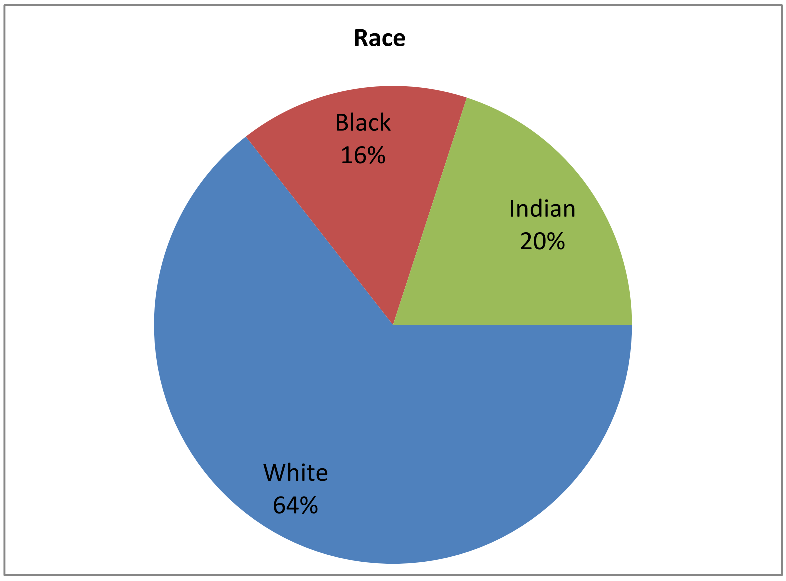


Figure 4.2 Race distribution (n=45)

The most significant contribution from participants came from the White female (n=15) group and the White male (n=14) group, followed by Indian female group (n=7) and Black female (n=5) and Indian males (n=2) and Black males (n=2) groups.

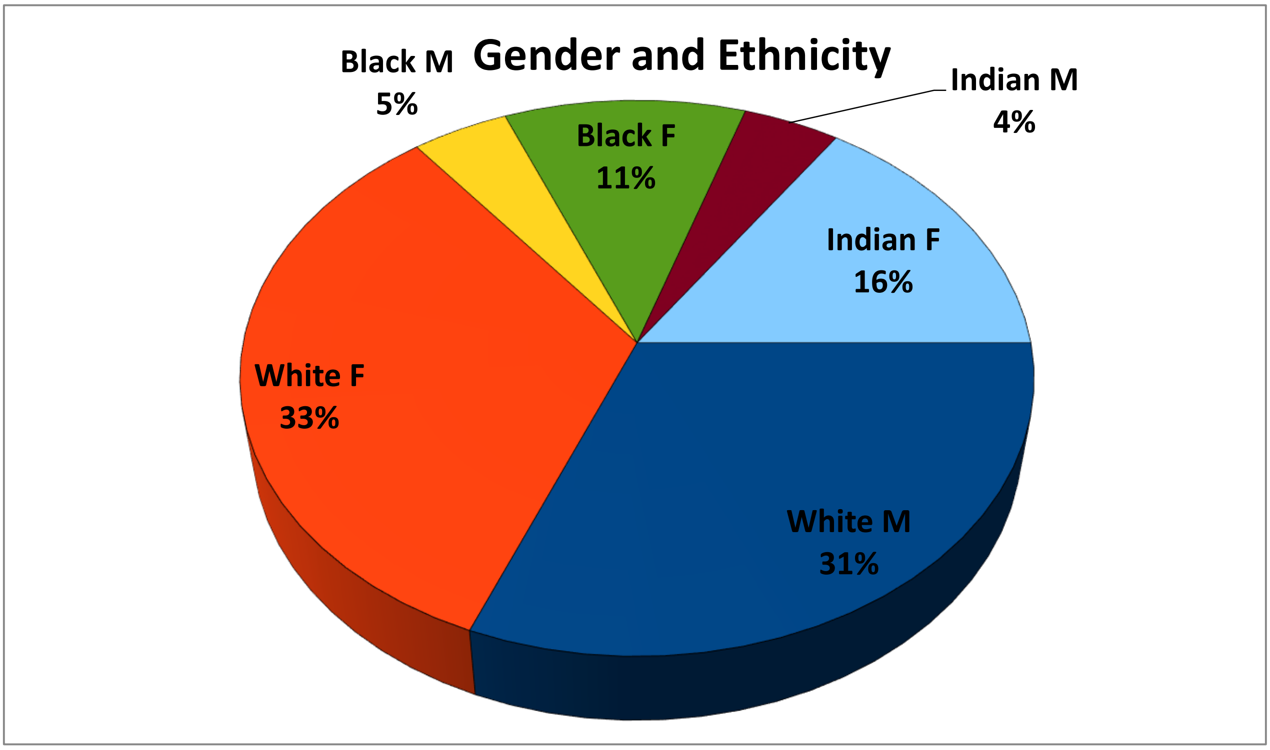


Figure 4.3 Gender and ethnicity (n=45)

4.5 Age distribution

Despite the fact that there was a similar age distribution across the group, the majority of participants were in age range A (19-25) (n=22) with a mean age of 22.8. Next was age range C (31-45) (n=13) with a mean age of 36.5, followed by B (26-30) (n=10) with a mean age of 28.4. Figure 4.4 shows the mean age of participants as 28 with 49% being in the 19-25 years of age range.

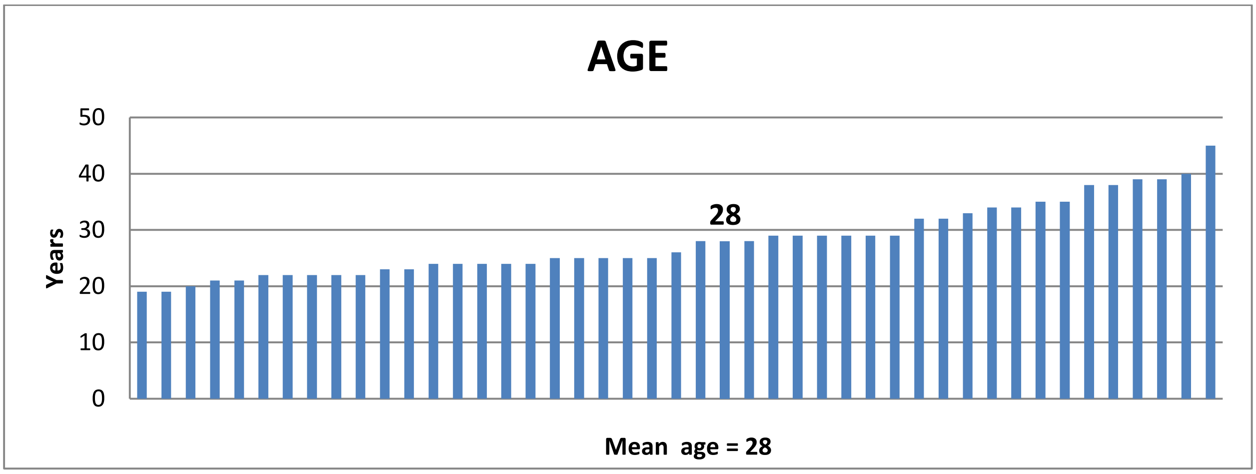


Figure 4.4 Age distribution (n=45)

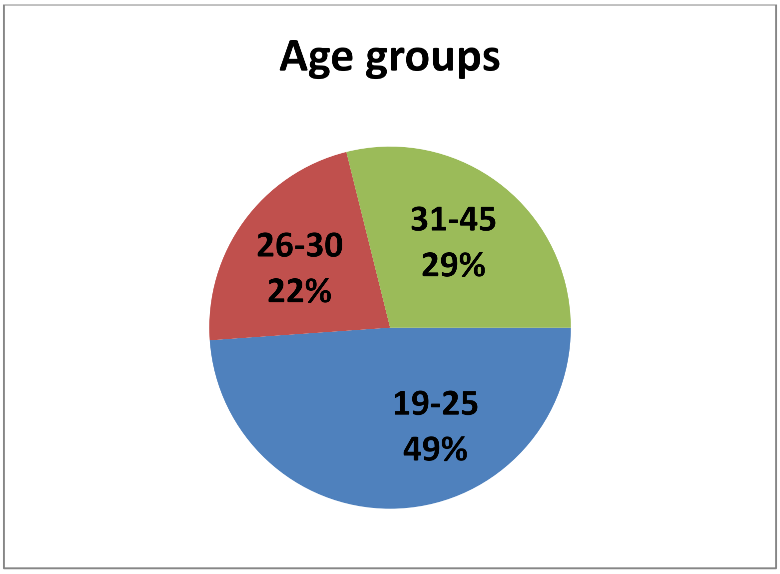


Figure 4.5 Age distribution (%) (n=45)

4.6 BMI distribution

The majority of participants (51%) were in the normal BMI range (n=23); whilst 9% were underweight (n=4), 22% were overweight (n=10) and 18% were obese (n=8). This is represented in Figure 4.5.

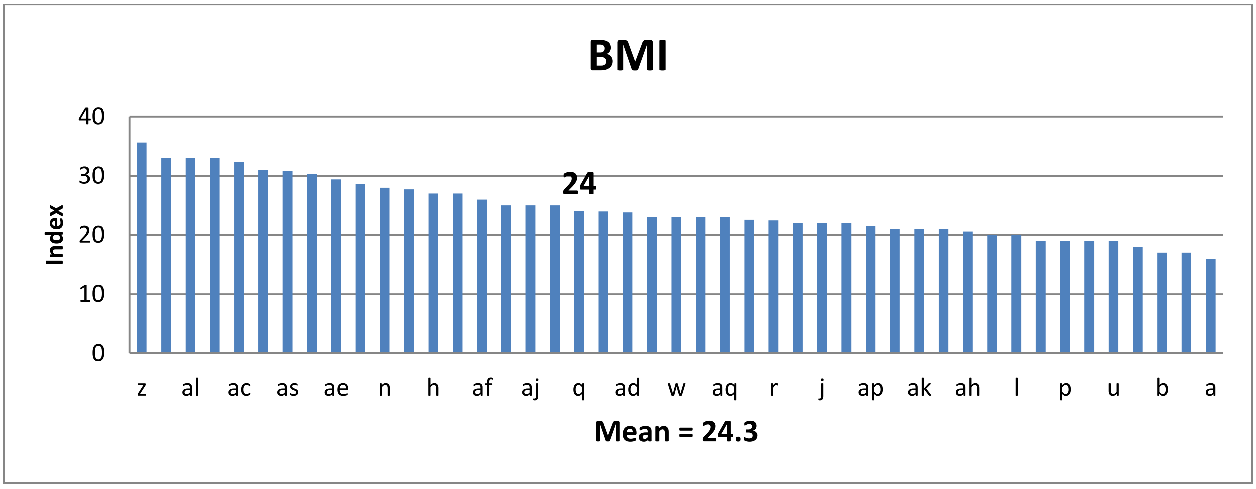


Figure 4.6 BMI distribution (n=45)

With respect to Figure 4.5.1, 51% of participants were within normal BMI range, 22% were overweight and 18% were obese.

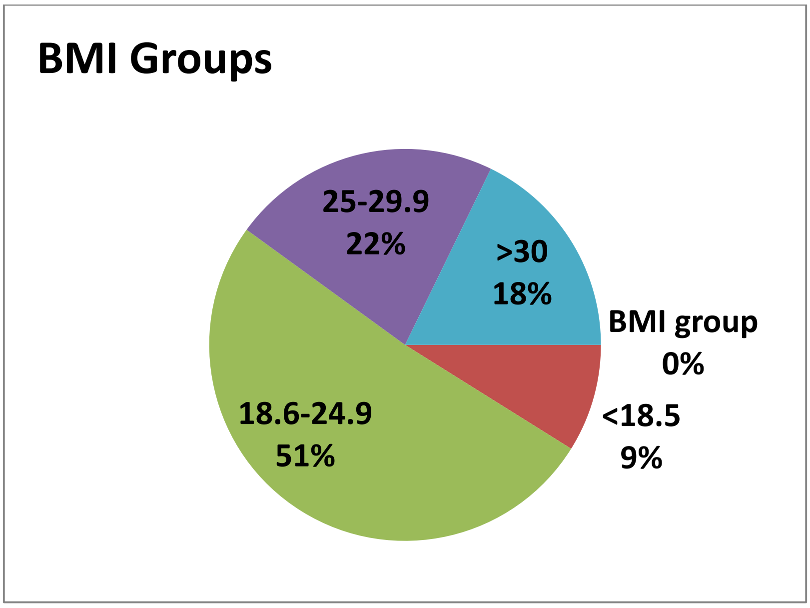


Figure 4.7 BMI distributions (%) (n=45)

4.7 Discussion of the demographics and presentation of measures

Based on the definitions provided by Robergs and Roberts (1997), which indicate that 5% muscle strength is lost per decade (after the age of 25 years of age) and additional decreases are noted with advancing age (most notably after 35 years of age) as well as the differential effects of age on the ability of muscle to strengthen. The statistics have been analysed by age so as to be able to determine the effect of the different age groups on participants. Thus the analysis of the age ranges were done from 19 – 25 years of age; 26 to 30 years of age and 31 to 45 years of age.

Additionally, the analyses have been separated per gender to determine whether the controversial suggestion that muscle strength training differentially affects men more positively then women (Robergs and Roberts, 1997; Cureton *et al*, 1988), has played a role in this particular study.

With the paucity of information on the effectiveness of exercise protocols in different ethnic groups, this study also assessed effects of ethnicity on the results obtained.

The effect of BMI on cervical range of motion and head posture has not been clearly outlined in the literature hence there is paucity with regard to this topic (Mannion et al., 1999; Robergs and Roberts, 1997). In this study BMI has not shown results that suggest it was an influential factor when assessing the results. Also the majority of participants in the study where within the normal BMI range (n=23) (18.5-24.9).

4.8 Overall measures

Neck pain is the complaint of pain in the anatomical region that is bounded by the base of the occiput superiorly, the third thoracic vertebrae inferiorly (Cote *et al,* 2003) and the attachments of the trapezius muscles laterally (Moore and Dalley, 1999; Standring, 2008). Therefore the area is of particular importance to chiropractors, as a large proportion of their participants present with neck pain, only some of which is amenable to chiropractic care. In other instances, it is possible that vital structures such as the vertebral arteries which traverse this area contra-indicate the use of manipulation in the treatment of neck pain (Haldeman, 2004). Therefore it is suggested that exercise may be a viable alternative in these participants.

Exercise in this context could therefore be applied to any participant in order to reduce symptoms related to neck pain and reduce its sequelae. In this respect cognisance needs to be given to age (Robergs and Roberts, 1997; Tortora and Derrickson, 2011), gender (Robergs and Roberts, 1997; Tortora and Derrickson, 2011), race and BMI (Robergs and Roberts, 1997; Mannion et al., 1999), as these have to varying degrees been noted to affect the effectiveness of this form of intervention. Thus this particular chapter will analyse the results in terms of these variables for each outcome measure (viz. range of motion and CV angle measures).

There was an above average compliance with a percentage of 88% making the results significant and reliable (Mouton, 1996; Mouton, 2000).

The overall data showed significantly increased improvement in all ranges of motion (n=45), with the exception of flexion which presented with decreased range of motion at completion of the study. Additionally, the CV angle showed significant improvement in both the seated and standing positions.

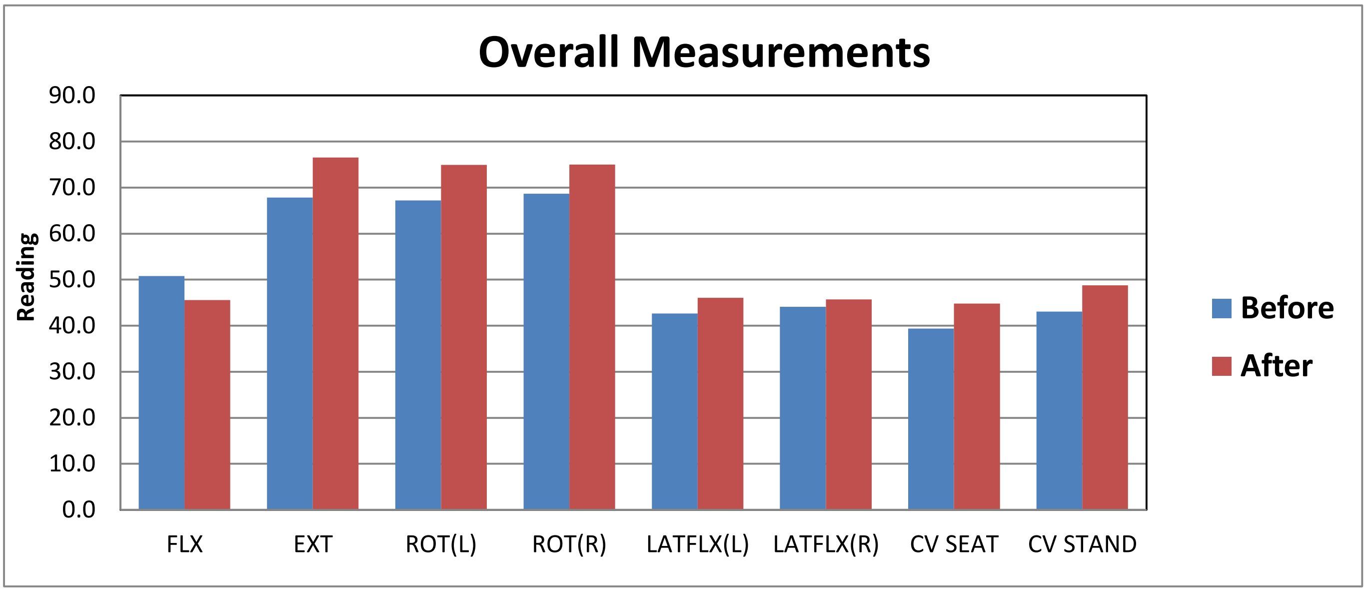


Figure 4.8 Overall results, range of motion, CV angles (n=45)

Figure 4.8 suggests that CCFEs improve posture and therefore the CV angle, which are both useful in increasing the range of motion within the motion parameters of the cervical spine and should be considered as a rehabilitation tool in the treatment and prevention of acute and chronic neck pain. Additionally CCFEs should be used as a tool in the prophylactic treatment of people who are at risk of developing mechanical neck pain and dysfunction.

4.9 The Craniovertebral Angles

The CV angles in both the seated and standing positions showed statistically significant improvement with *p* values of (*p*=0.00000002) and (*p*=0.000003) respectively.

4.9.1 The Craniovertebral Angle – Seated

The craniovertebral angle showed statistically significant improvement (*p*=0.00000002) in the seated position representing improved cervical posture in the seated position.

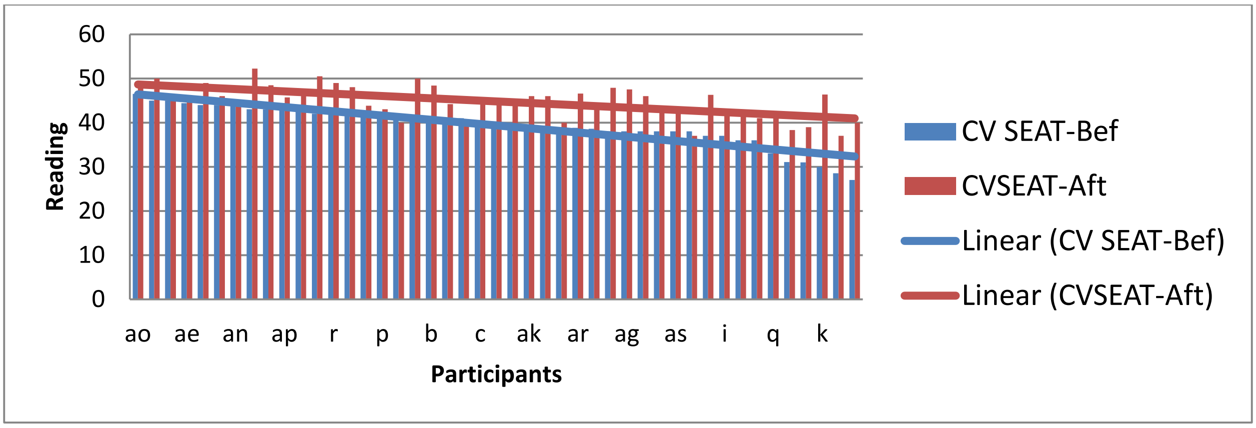


Figure 4.9 Pre / post CV angle measures (n=45)

The seated CV angle showed significant improvement after the implementation of the CCFE protocol.

Possible reasons for this improvement could include:

- The high level of participant compliance (Mouton, 1996)
- The “Hawthorne effect” (Mouton, 1996). This may result from the fact that participants are being observed and hence respond to the observation by improving their posture. Additionally, it may also be possible that because the participants are actively required to keep a diary and maintain an exercise protocol that they are also more acutely aware of their posture and thus making changes when they are being observed.
- The possibility that when the participant is seated, the core muscles are actively engaged and assist (Jull and Sterling, 2008) with improving good posture as a result of the stability of the pelvis. With this support the centre of gravity is improved, improving the likelihood of good posture (Liebenson, 2007).

4.9.2 The Craniovertebral Angle – Seated - Gender

When considering these readings with reference to gender, statistical significance is still notable with male CV seated showing results of (n= 18) (p=0.00014) and CV seated female showing results of (n=27) (p=0.000022).

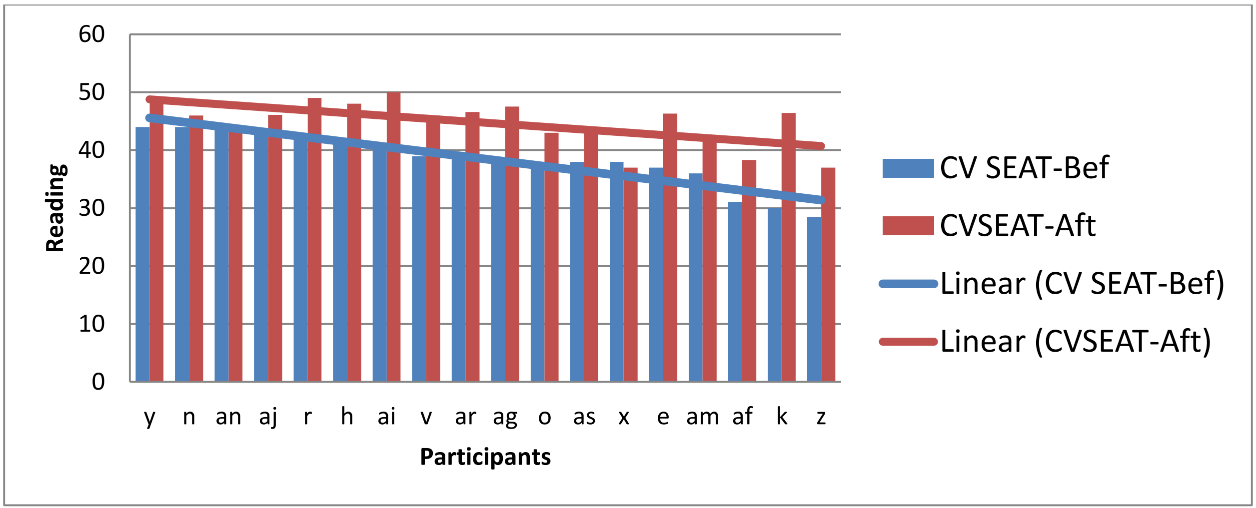


Figure 4.10 Pre - post seated CV angle measures, male only (n=18)

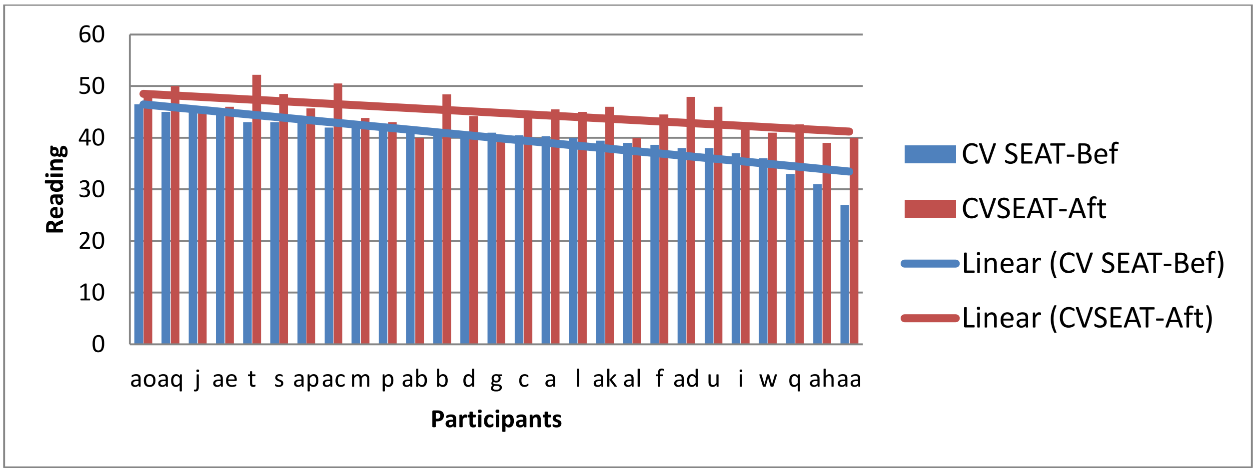


Figure 4.11 Pre - post seated CV angle measures, female only (n=27)

4.9.3 The Craniovertebral Angle – Seated – Ethnicity

When comparing CV seated scores across the ethnic groups presented in the study, White (n= 29) (*p*= 0.0000050) and Indian (n=9) (*p*=0.00304) participants showed statistically significant results whilst the Black participants (n=7) (*p*=0.12392) results were not significant. This is likely due to the low numbers of black participants represented in the study.

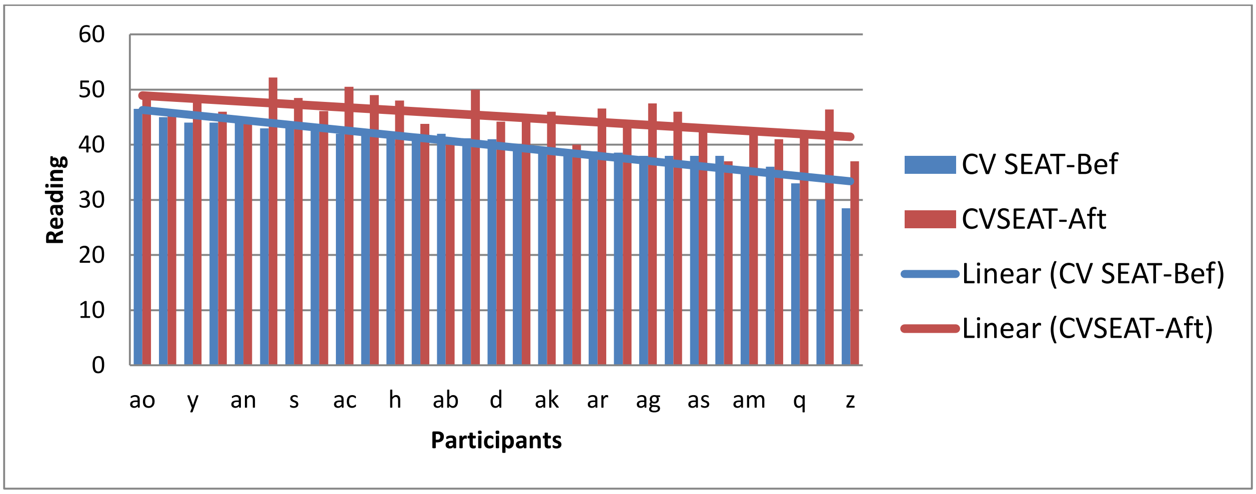


Figure 4.12 Pre - post seated CV angle measures, White only (n=29)

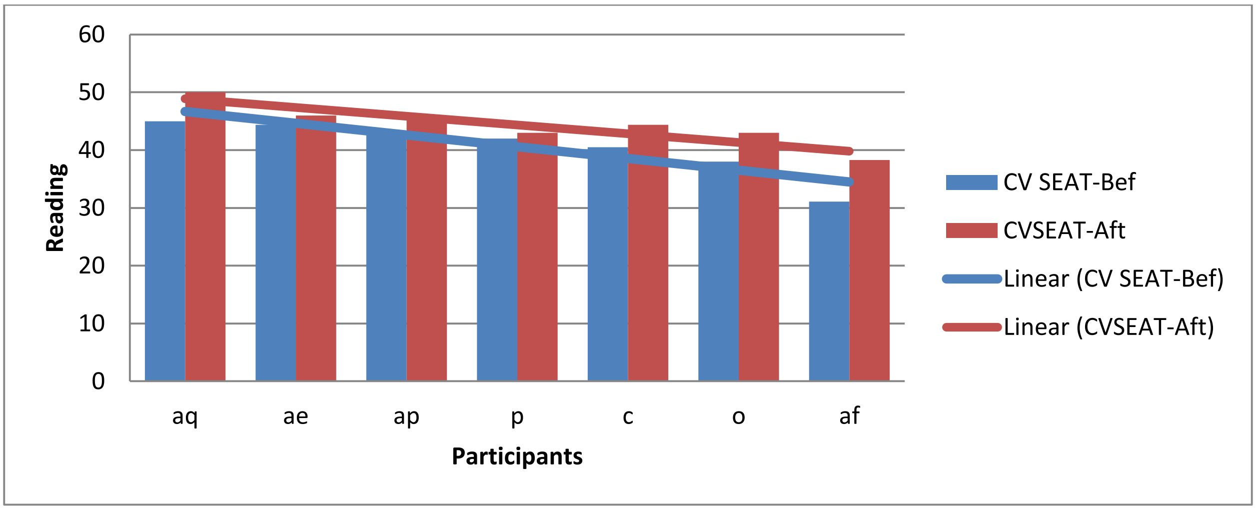


Figure 4.13 Pre - post seated CV angle measures, Black only (n=9)

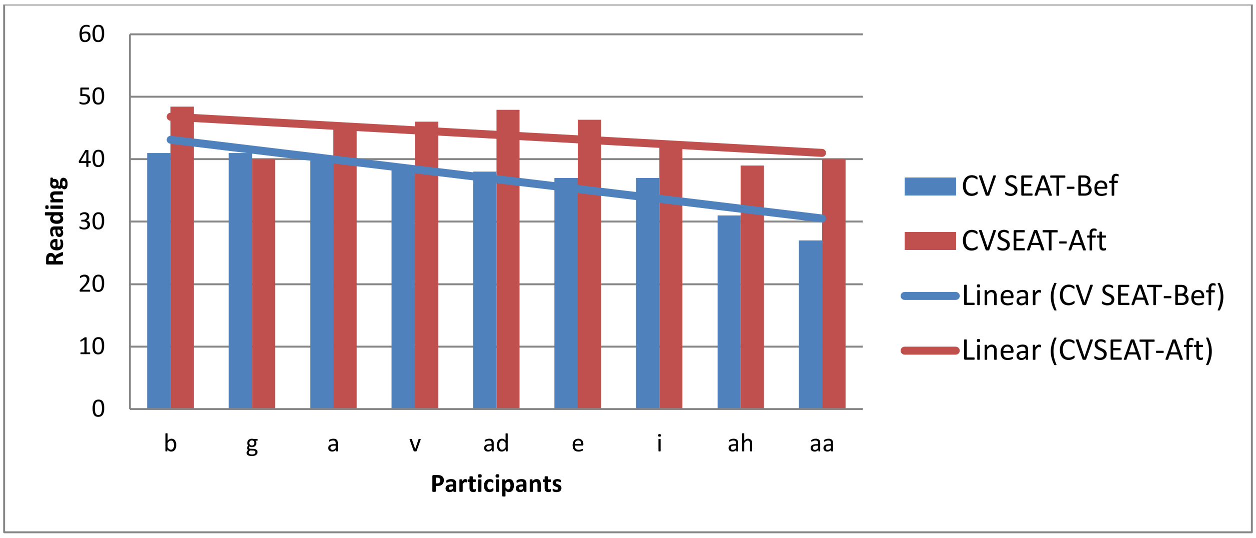


Figure 4.14 Pre - post seated CV angle measures, Indian only (n=7)

The most significant results with regard to ethnicity where noted in the White group, this is probably as a result of the larger sample of participants in this group**.**

4.9.4 The Craniovertebral Angle – Seated – BMI

In the BMI B range which was representative of the normal weight participants (18.5-24.9), and the BMI C range (25-25.9) which was representative of the overweight participants, the results showed improvement (*p*=<0.05) showing statistical significance when observing post intervention results in the seated CV angle measurement. In BMI A (Figure 4.8) and BMI D (Figure 4.8.3) the results were insignificant due to the number of participants being too few. This was consistent with the BMI dependant readings in the CV standing post intervention results.

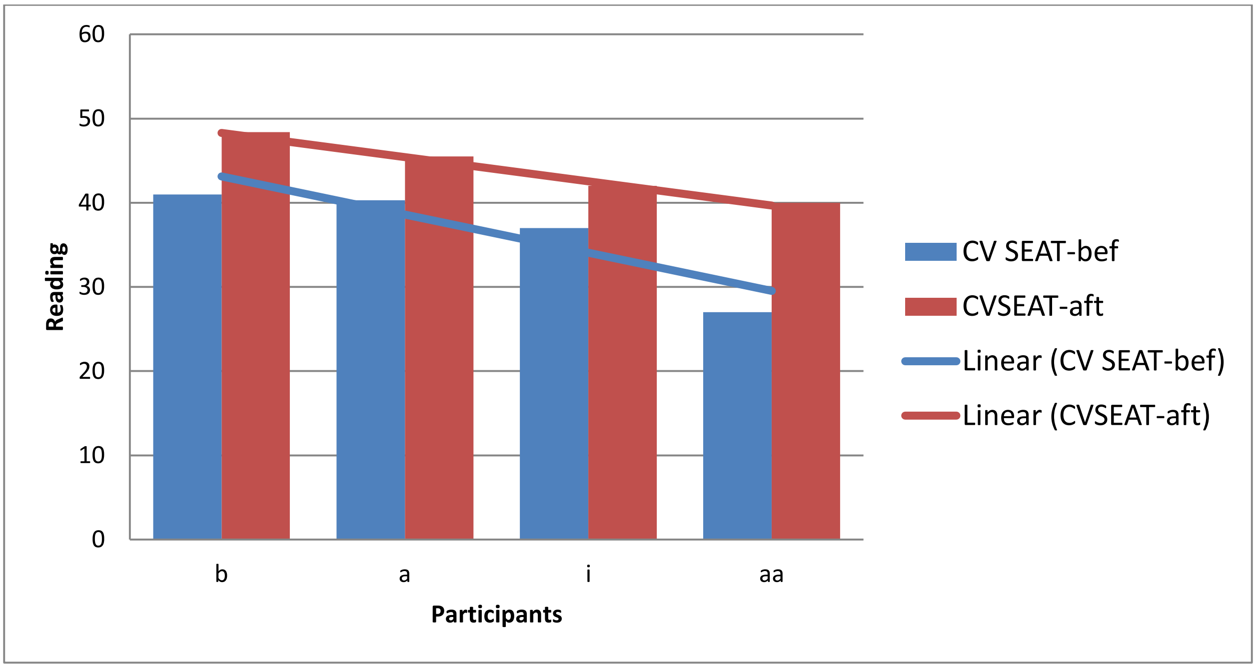


Figure 4.15 Pre - post seated CV angle measurements, BMI dependant, group A (<18.5) (n=4)

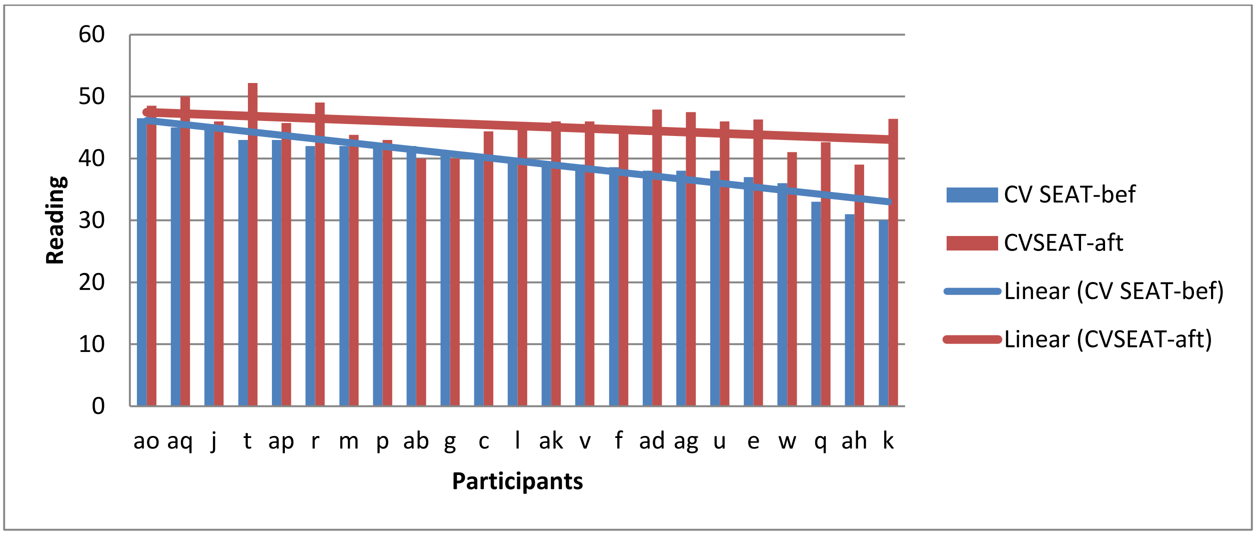


Figure 4.16 Pre – post seated CV angle measurements, BMI dependant, group B (18.5-24.9) (n=23)

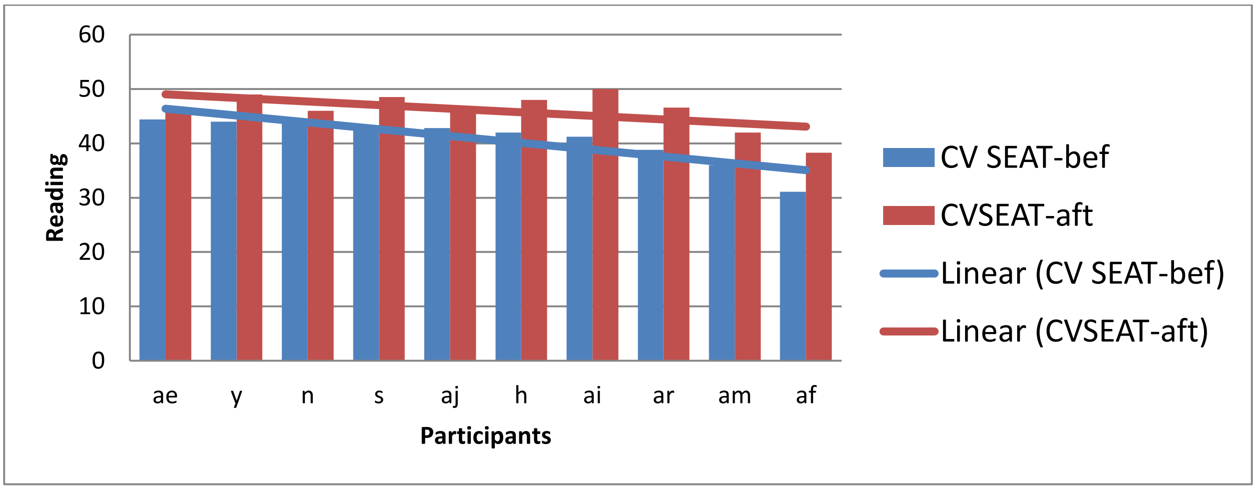


Figure 4.17 Pre – post seated CV angle measurements, BMI dependant, group C (25-29.9) (n=10)

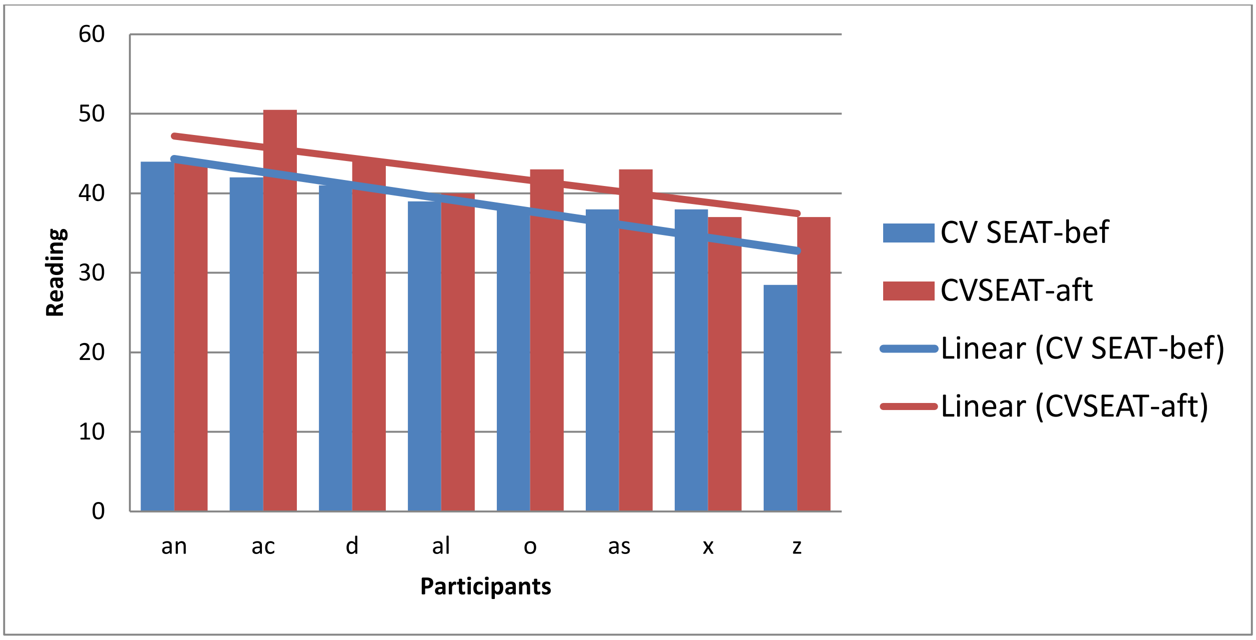


Figure 4.18 Pre – post seated CV angle measurements, BMI dependant, group D (>30) (n=8)

BMI results have demonstrated statistically insignificant in this group as these results are related more to the size of the sample than is representative of the group. Therefore it would be suggested to rather equally divide these groups to better assess the results in future studies.

P values CV seated- overall, gender, ethnicity and BMI (Table 4.1)

Overall p-value	**Sub-group**	**Number of Participants (n=)**	***p*-value**	**BMI**	**Number of participants (n=)**	***p*- value**
0.00000002	M	18	0.00014	A	4	0.095319618
	F	27	0.00002	B	23	0.000008162
	W	29	0.00083	C	10	0.007414857
	B	7	0.0603	D	8	0.116970391
	I	9	0.00649			

4.10 The Craniovertebral Angle – Standing

Again when comparing the above CV standing readings with regard to statistical significance, the overall reading were statistically significant (n=45) (*p*= 0.0000038).

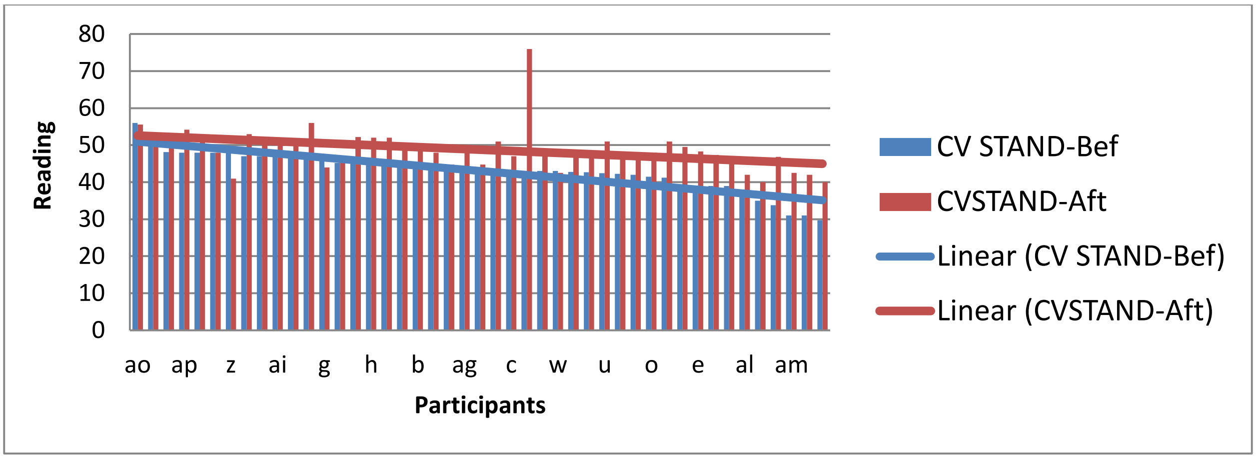


Figure 4.19 Pre - post standing CV angle measurements, overall (n=45) (*p*= 0.000003)

The standing CV angle shows statistical significance (*p*=<0.005), although this significance is less so than the seated overall reading. This is likely due to the effect of gravity on the standing posture requiring greater co-contraction from the postural musculature (Jull and Sterling, 2008). Similar to the seated results, it must be postulated that the Hawthorn effect may be another factor to consider when considering this improvement in results.

4.10.1 The Craniovertebral Angle – Standing – Gender

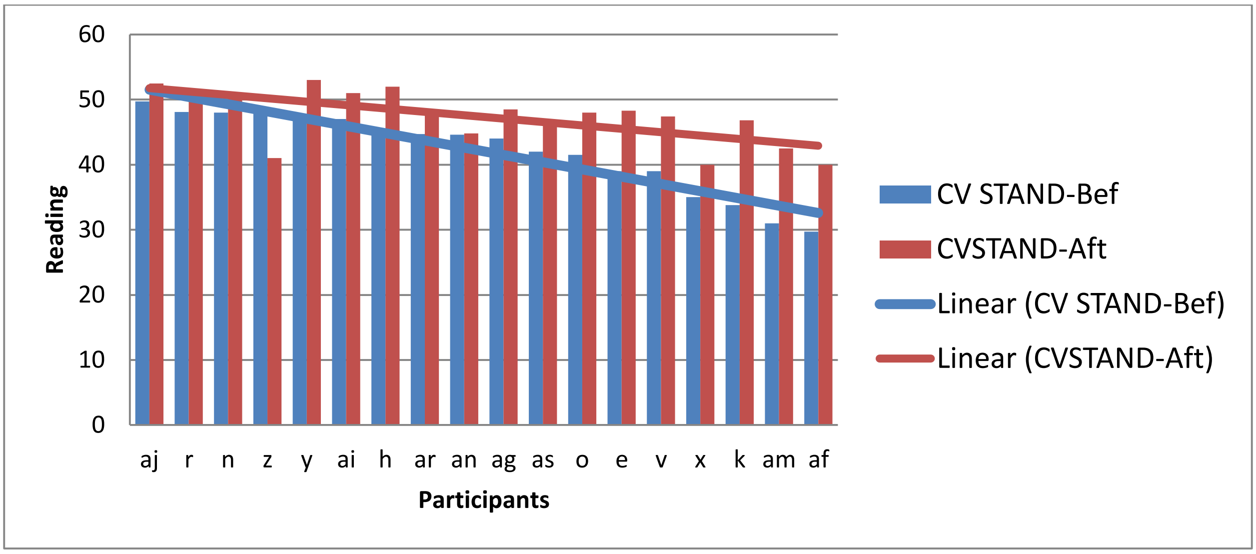


Figure 4.20 Pre - post standing CV angle measurements, male only (n=18) (*p*=0.005578379)

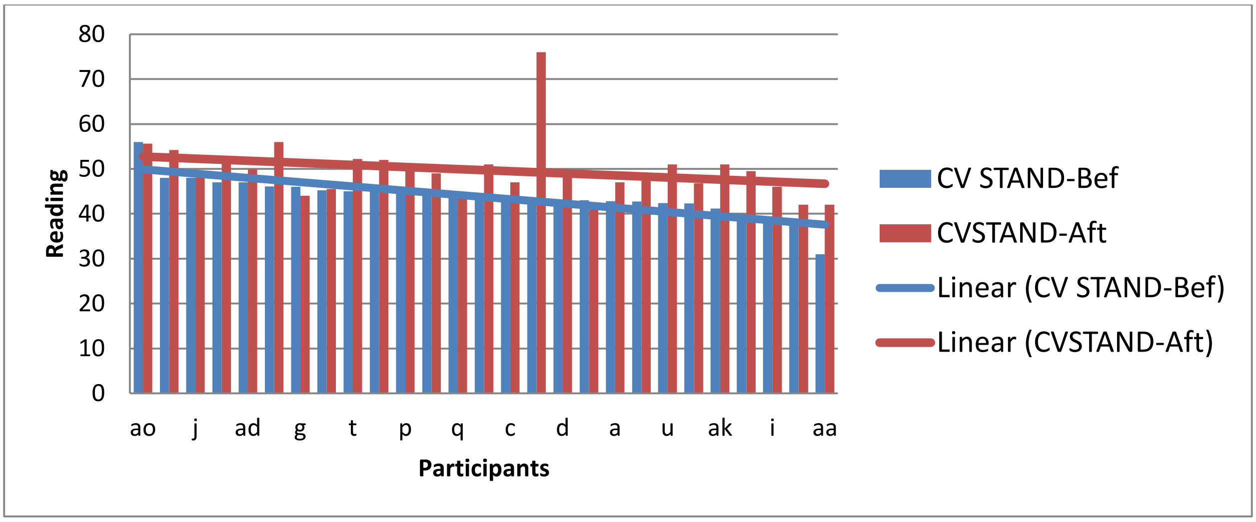


Figure 4.21 Pre – post standing CV angle measurements, female only (n=27) (*p*=0.000258116)

4.10.2 The Craniovertebral Angle – Standing – Ethnicity

The White ethnic group (n= 29) (*p*=0.00083) and Indian (n=9) (*p*=0.00649501) participants showed statistically significant results whilst the Black participants (n=7) (*p*=0.06032) results were not significant. This is likely due to the low number of black participants represented in the study.

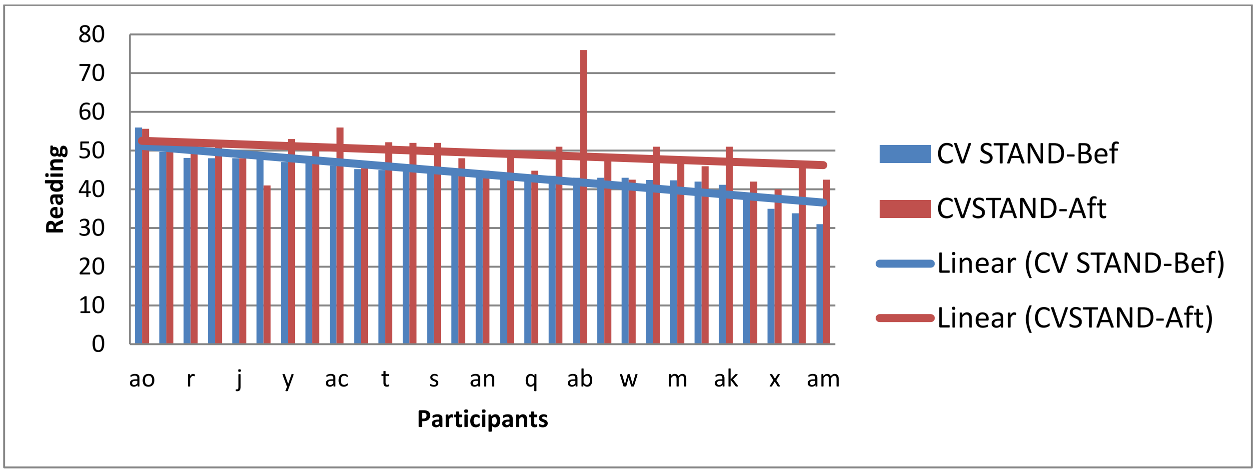


Figure 4.22 Pre - post standing CV angle measurements, white only (n=29) (*p*=0.00083)

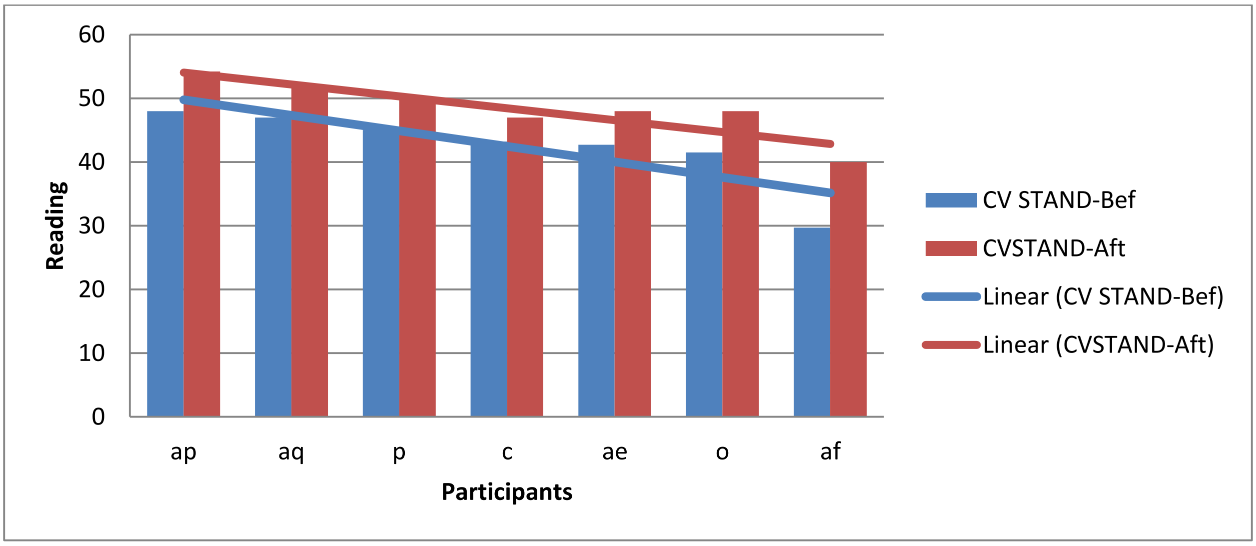


Figure 4.23 Pre – post standing CV angle measurements, Black only (n=7) (*p*=0.06032)

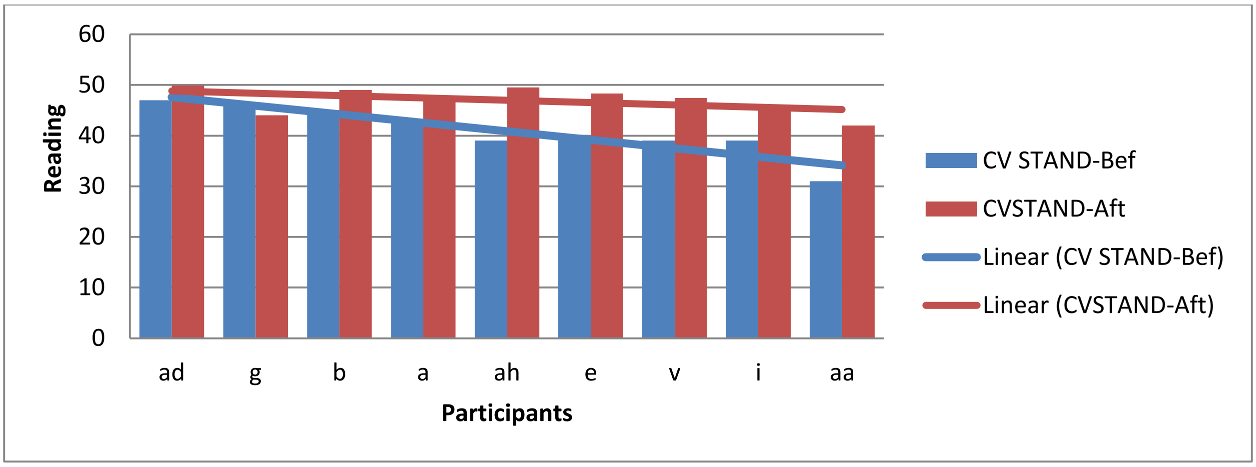


Figure 4.24 Pre – post standing CV angle measurements, Indian only (n=9) (*p*=0.00649501)

4.10.3 The Craniovertebral Angle – Standing – BMI

Participants in the BMI B range which was representative of the normal weight participants (18.5-24.9), and the BMI C range (25-25.9) which was representative of the overweight participants, the results showed improvement (p=<0.05) showing statistical significance when observing post intervention results in the seated CV angle measurement. In (Figure 4-25) and (Figure 4.27) the results were insignificant due to the number of participants being too few. This was consistent with the BMI dependant readings in the CV standing post intervention results.

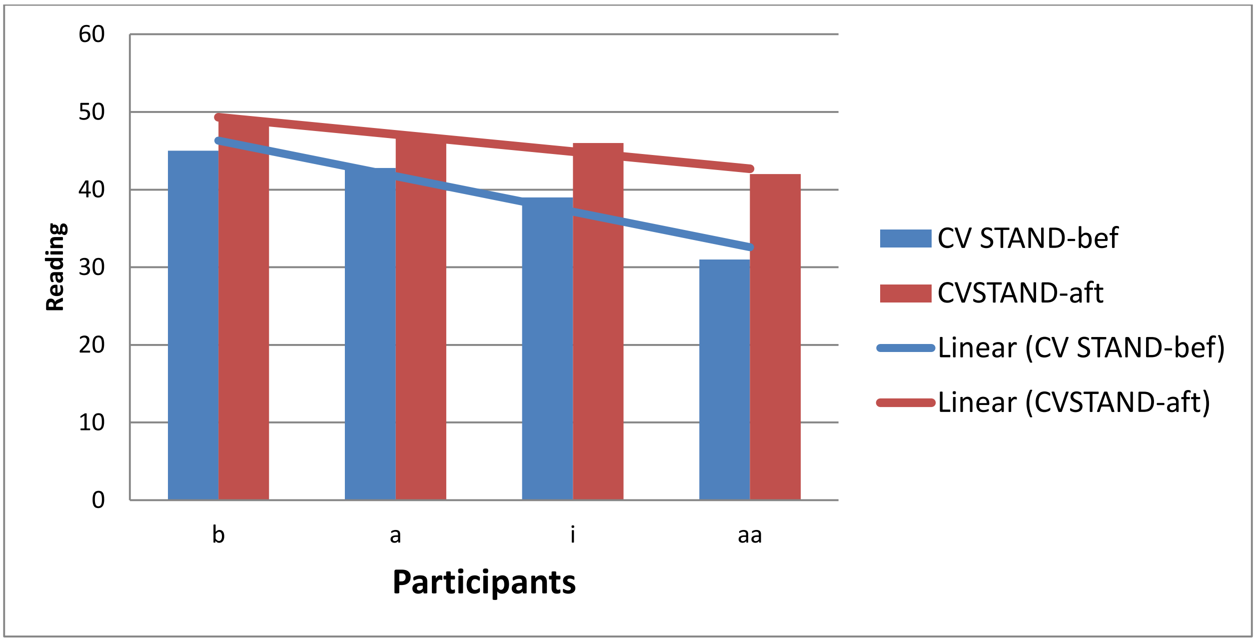


Figure 4.25 Pre – post standing CV angle measurements, BMI dependant, group A (<18.5) (n=4) (*p*=0.127244738)

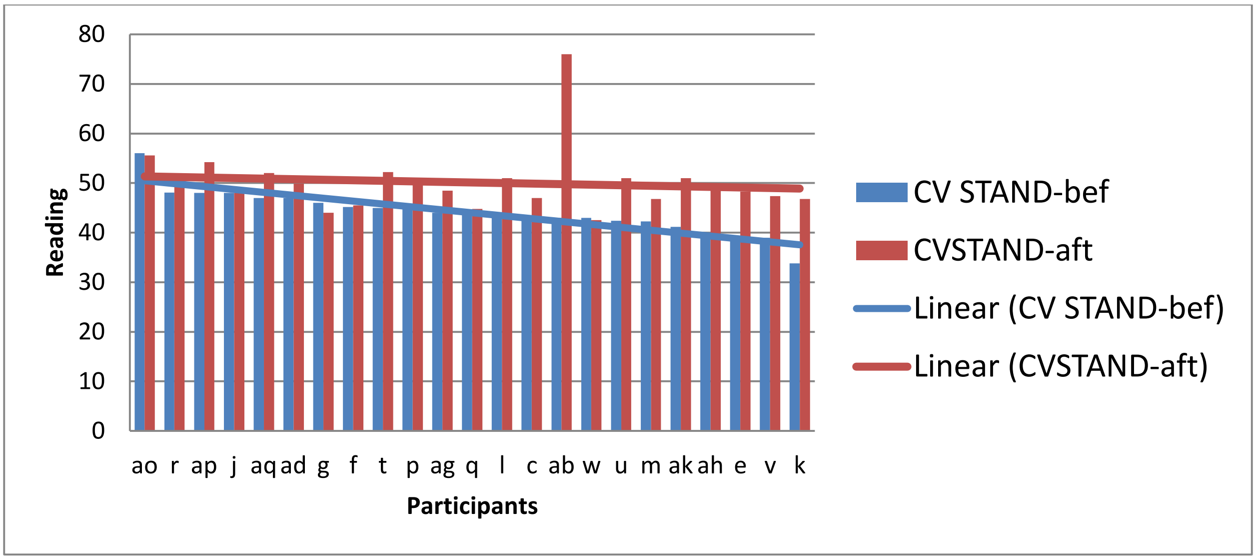


Figure 4.26 Pre – post standing CV angle measurements, BMI dependant, group B (18.5-24.9) (n=23) (*p*= 0.000562367)

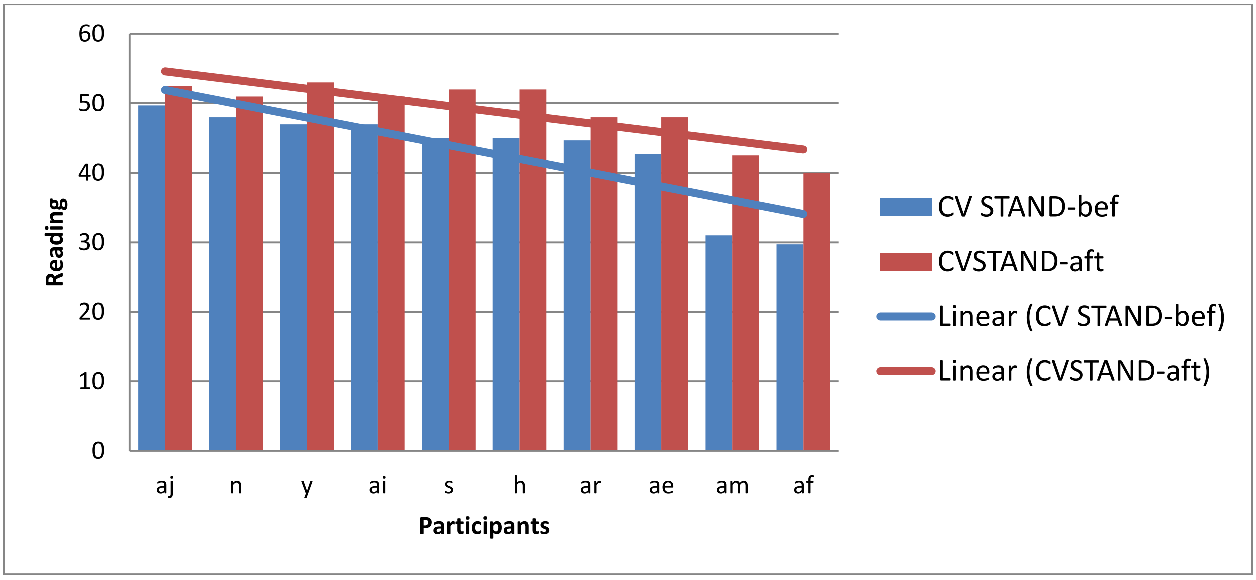


Figure 4.27 Pre – post standing CV angle measurements, BMI dependant, group C (25-29.9) (n=10) (*p*=0.035792693)

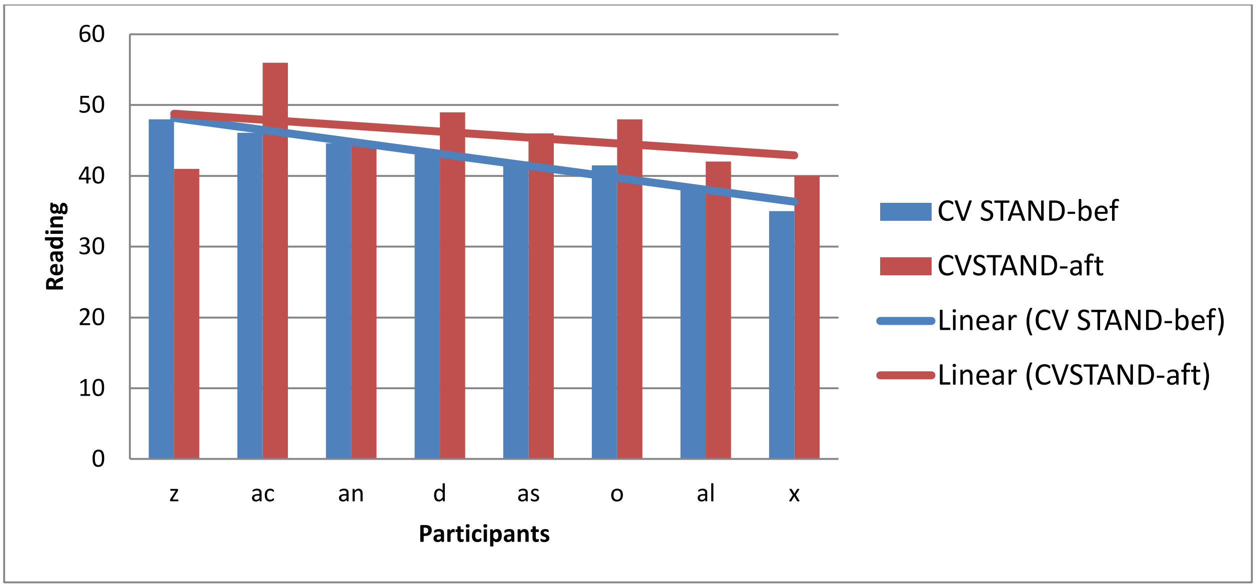


Figure 4.28 Pre - post standing CV angle measurements, BMI dependant, group D (>30) (n=8) (*p*=0.156524813)

P values CV standing- overall, gender, race and BMI (Table 4.2)

Overall p-value	Sub-group	Number of participants (n=)	*p*-value	BMI	Number of participants (n=)	*p*- value
0.000003	M	18	0.00557	A	4	0.127244738
	F	27	0.00025	B	23	0.000562367
	W	29	0.00083	C	10	0.035792693
	B	7	0.0603	D	8	0.156524813
	I	9	0.00649			

4.11 Range of motion

4.11.1 Cervical range of motion - Extension – Overall

Cervical range of motion showed significant improvement in all ranges. Extension over all (figure 4.29) showed that all participants improved with statistically significant results (*p*=0.0000002) (n=45)

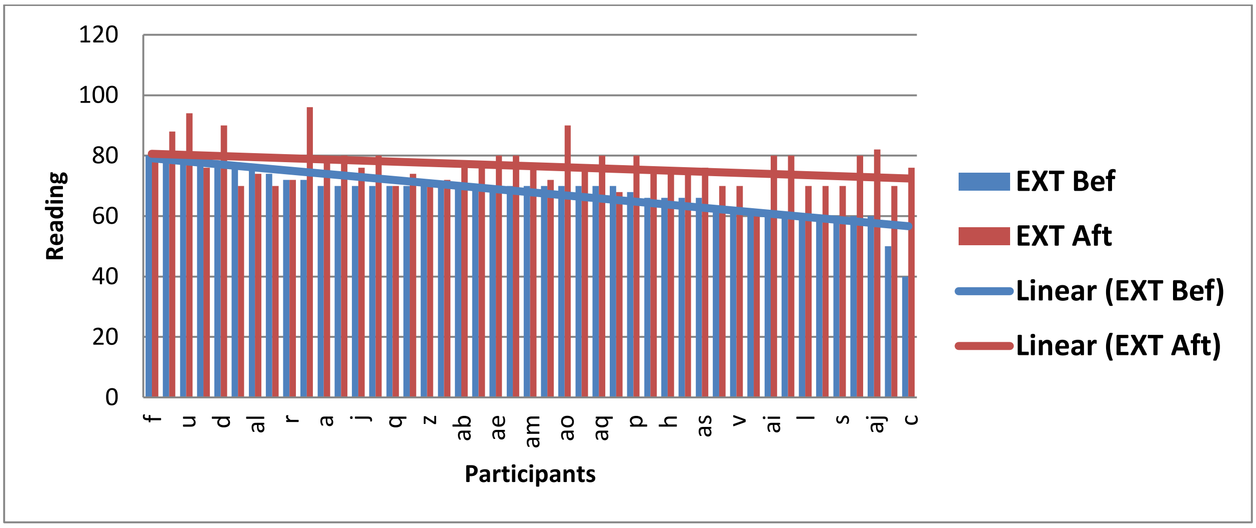


Figure 4.29 Overall results, range of motion, extension (*p*=0.0000002) (n=45)

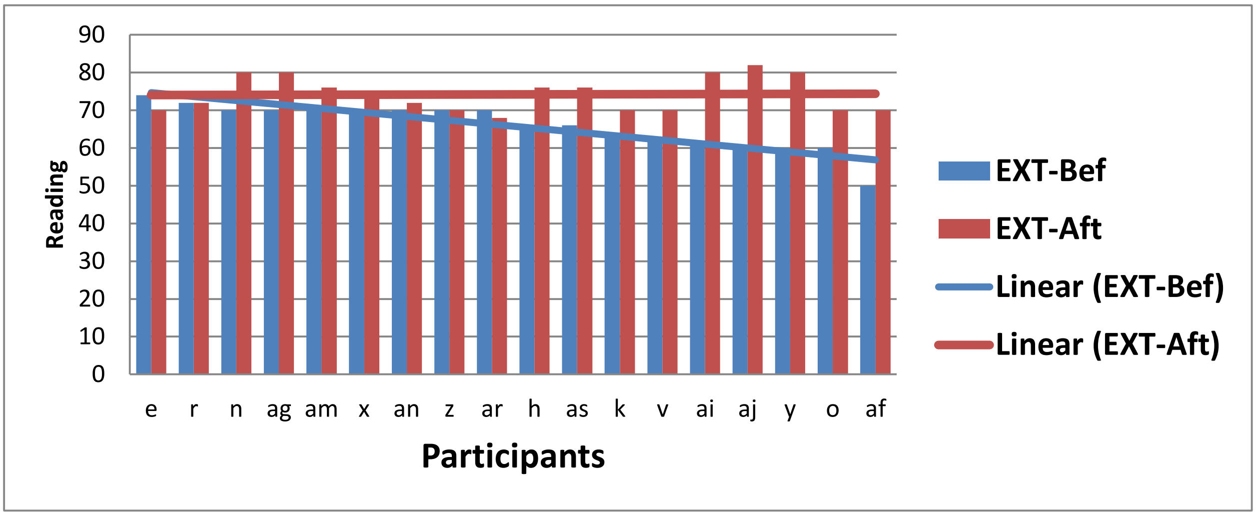
Extension showed remarkable improvement in terms of the range of motion results, the Hawthorn effect can be safely excluded here as these measurements were taken at the extremes of active range of motion, in this case extreme extension.

This can be explained by extensor muscle remodelling and revascularization of tissue, thus allowing the relaxation of this muscle with improved range of motion (Tortora and Derrickson, 2006) (Robergs and Roberts, 1997). Also as a result of improved DCF activation the cervical spine will be inherently more stable allowing greater ranges of motion in the sagittal plane (Liebenson, 2007)

4.11.2 Cervical range of motion - Extension – Gender

When comparing extension between genders male (n=18) and female (n=27) both showed statistically significant results with (*p*=<0.005).

Figure 4.30 Overall results, range of motion, extension, male only (n=18) (p=0.000046)



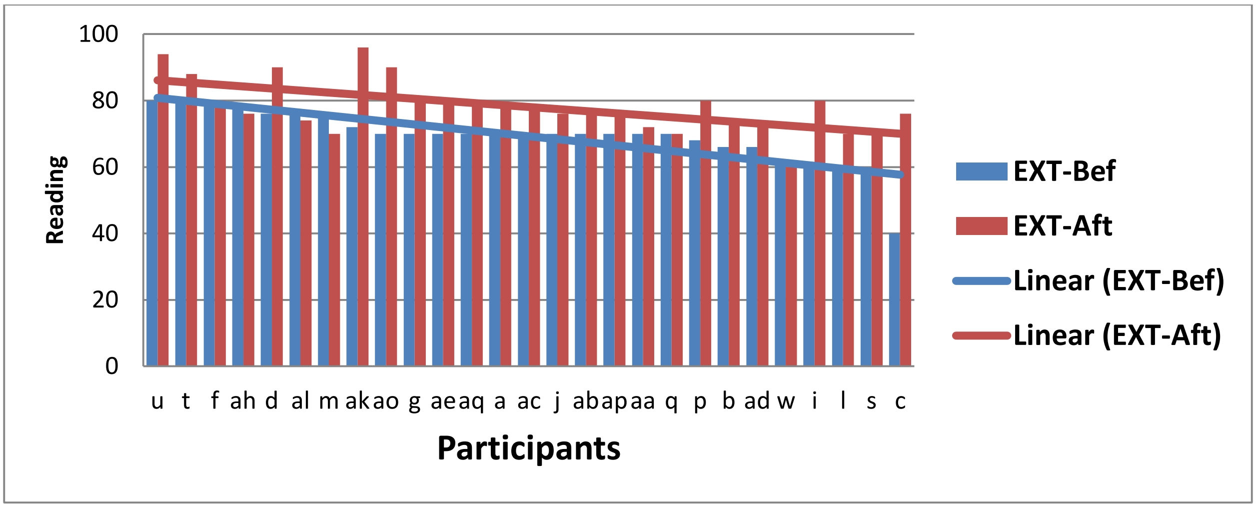


Figure 4.31 Overall results, range of motion, extension, female only (n=27) (*p*=0.0002121)

4.11.3 Cervical range of motion - Extension – Ethnicity

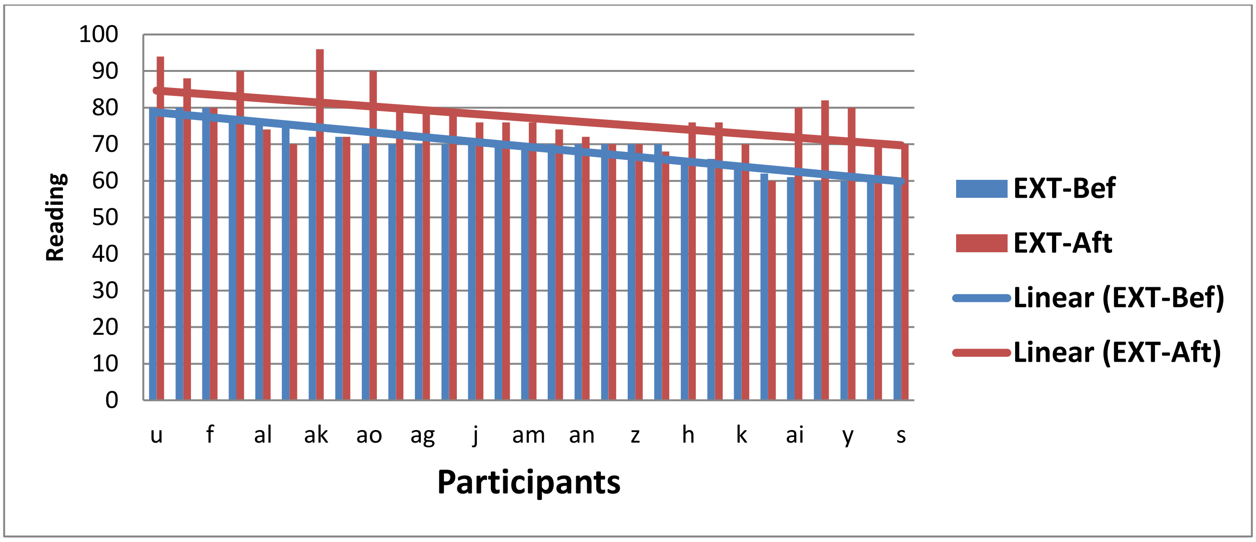


Figure 4.32 Overall results, range of motion, extension, white (n=29) (*p*=0.00013528)

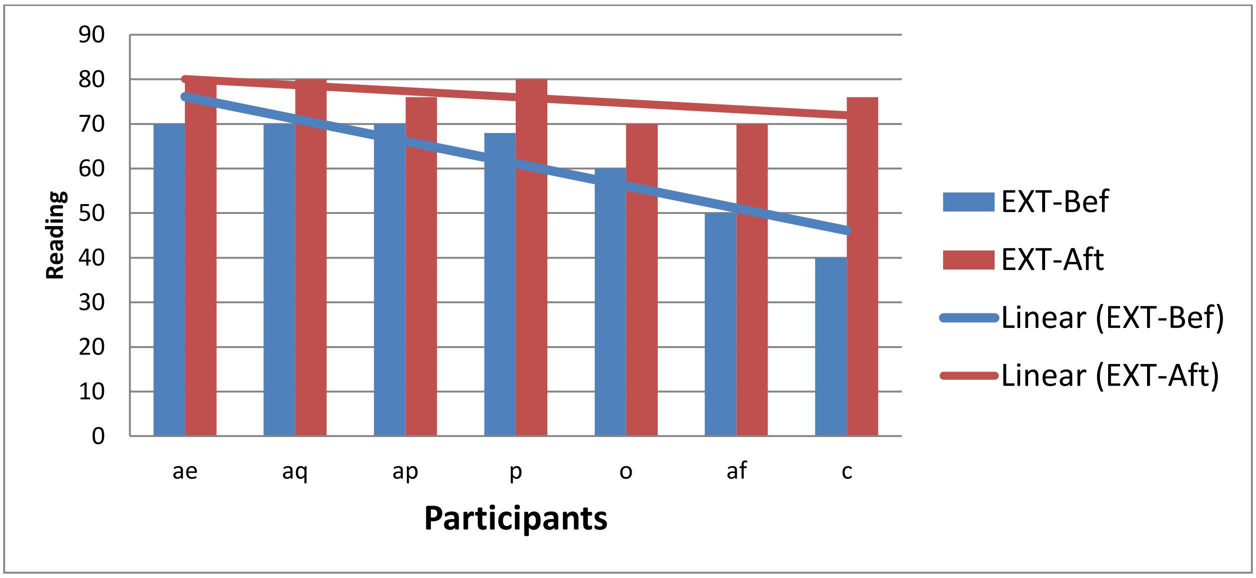


Figure 4.33 Overall results, range of motion, extension, black (n=7) (*p*=0.01503)

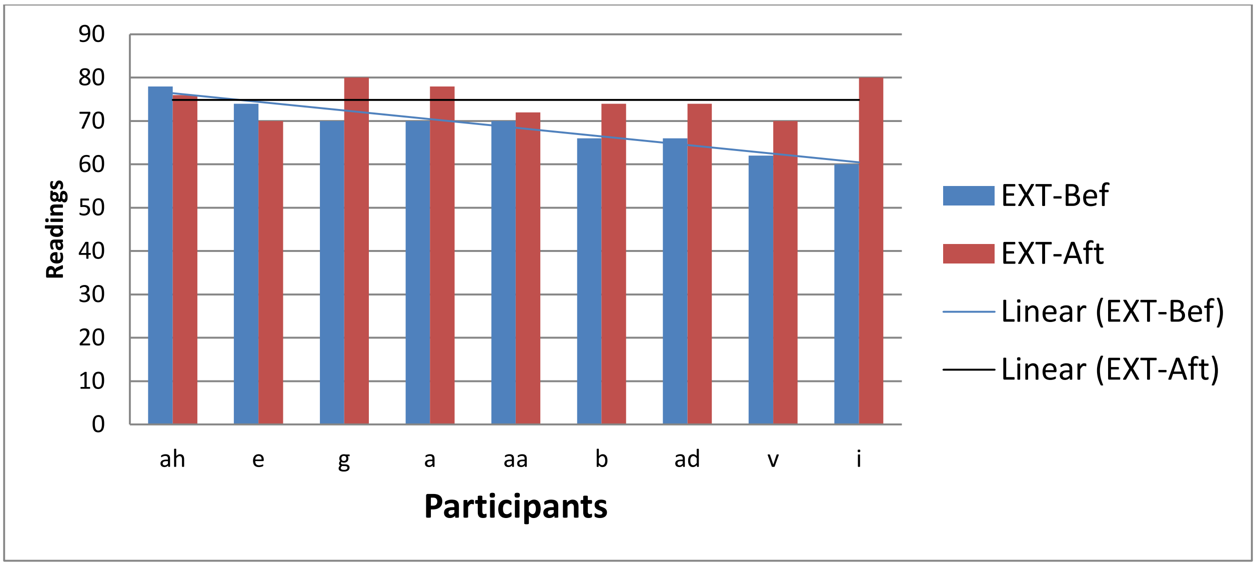


Figure 4.34 Pre-post overall results, range of motion, extension, Indian (n=9) (p=0.01354)

4.11.4 Cervical range of motion – Extension - BMI

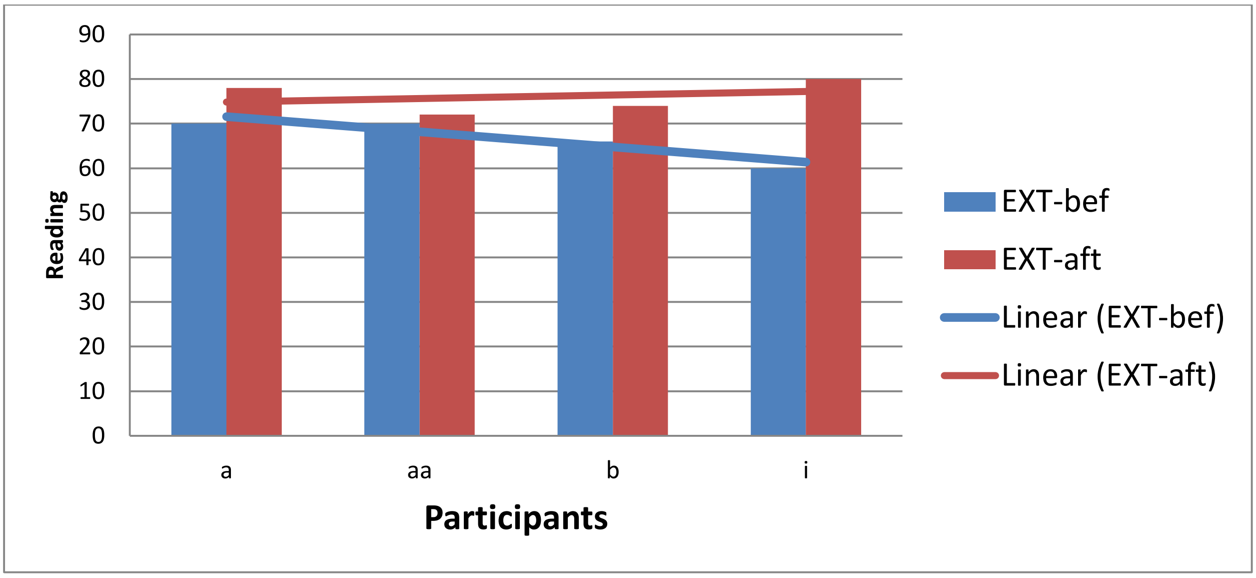


Figure 4.35 Pre–post cervical range of motion, extension, BMI dependant, group A (<18.5) (n=4)

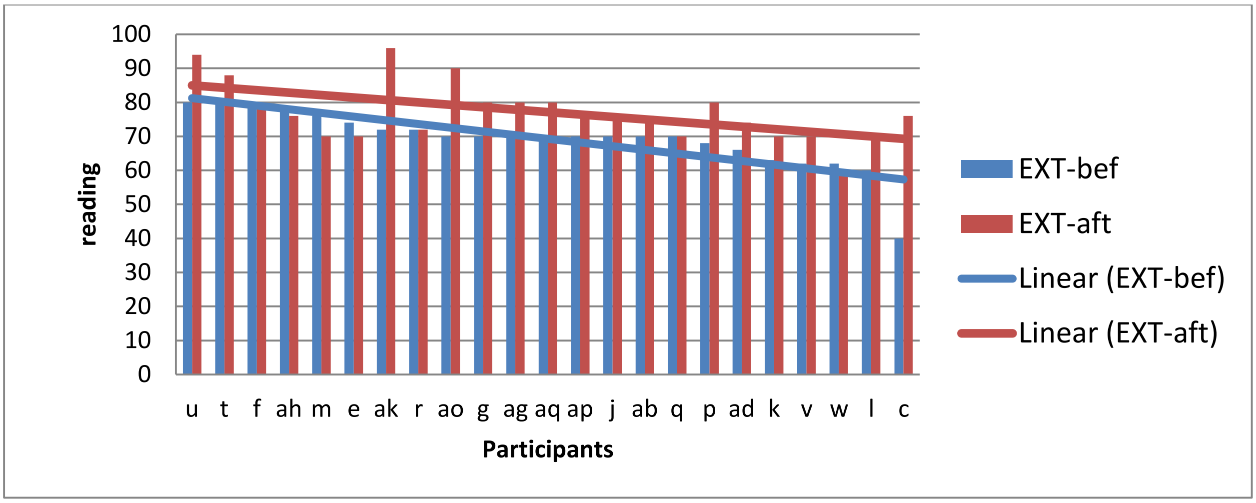


Figure 4.36 Pre–post cervical range of motion, extension, BMI dependant, group B (18.5-24.9) (n=23)

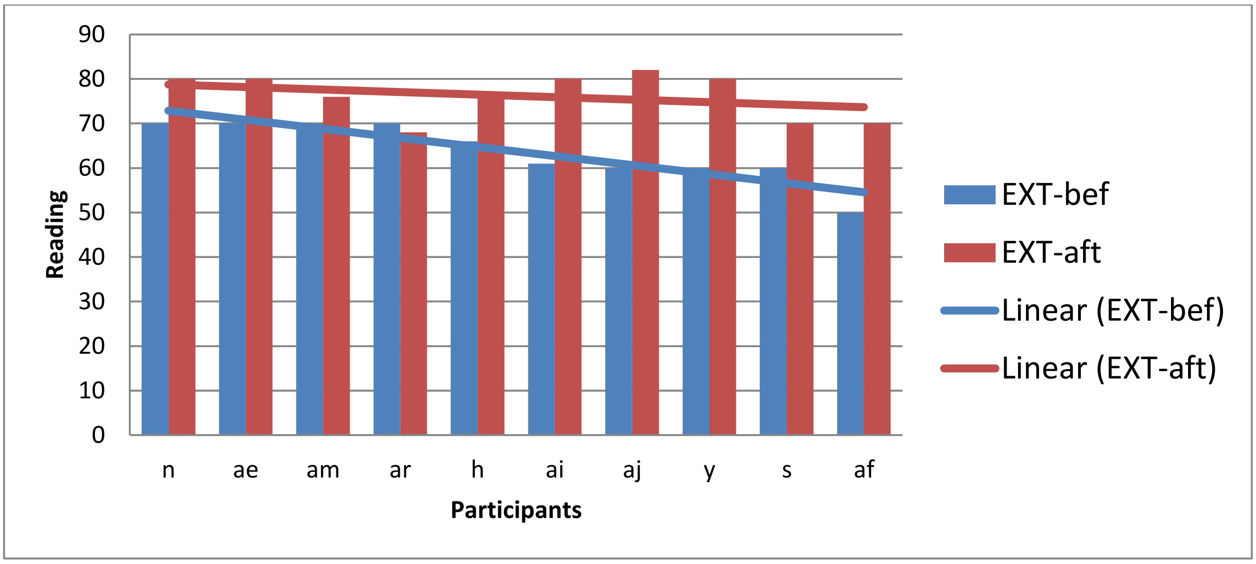


Figure 4.37 Pre–post cervical range of motion, extension, BMI dependant, group C (25-29.9) (n=10)

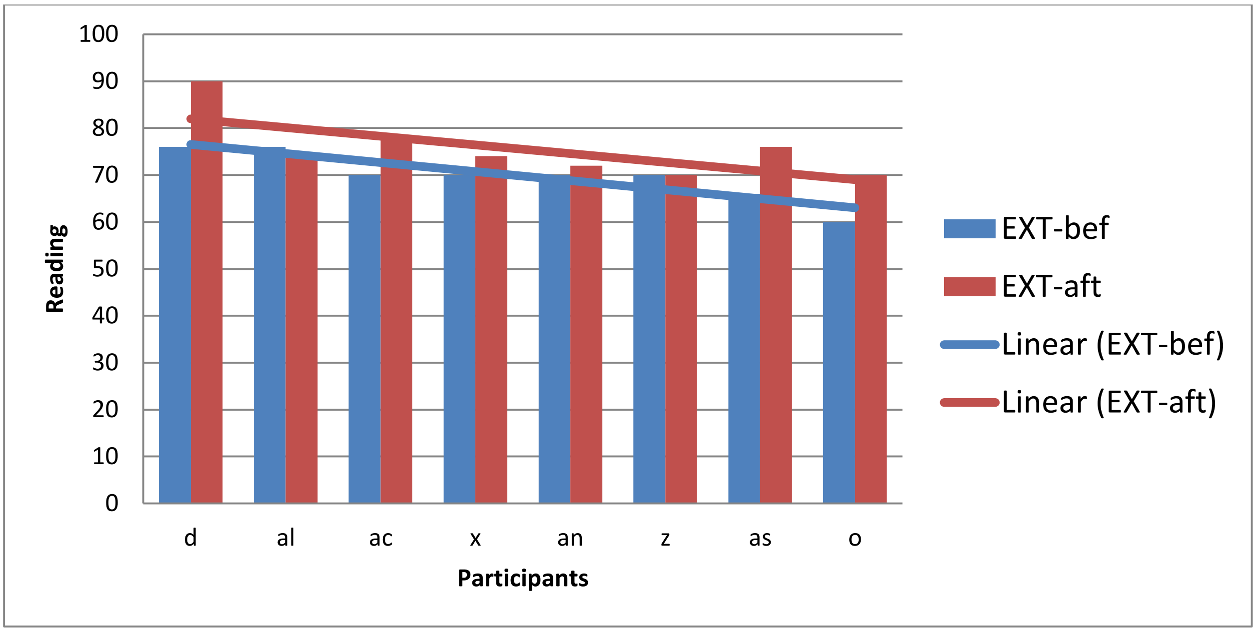


Figure 4.38 Pre–post cervical range of motion, extension, BMI dependant, group D (>30) (n=8)

4.11.5 Cervical range of motion – Extension - Age

Range of motion results, particularly extension, when measured specific to age groups showed a significant increase in all groups with the most significant improvement being in age group B (26-30) (p=0.000539). This is likely because this group had the highest number of participants.

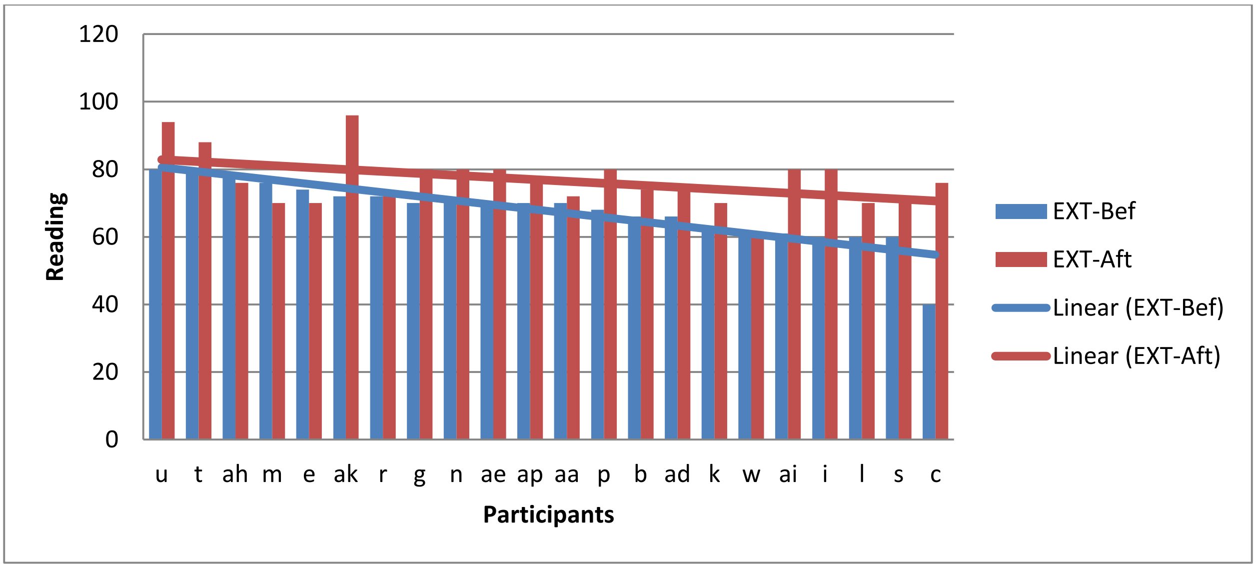


Figure 4.39 Pre–post cervical range of motion, extension, Age dependant, group A (19-25) (n=22) (p= 0.001014801)

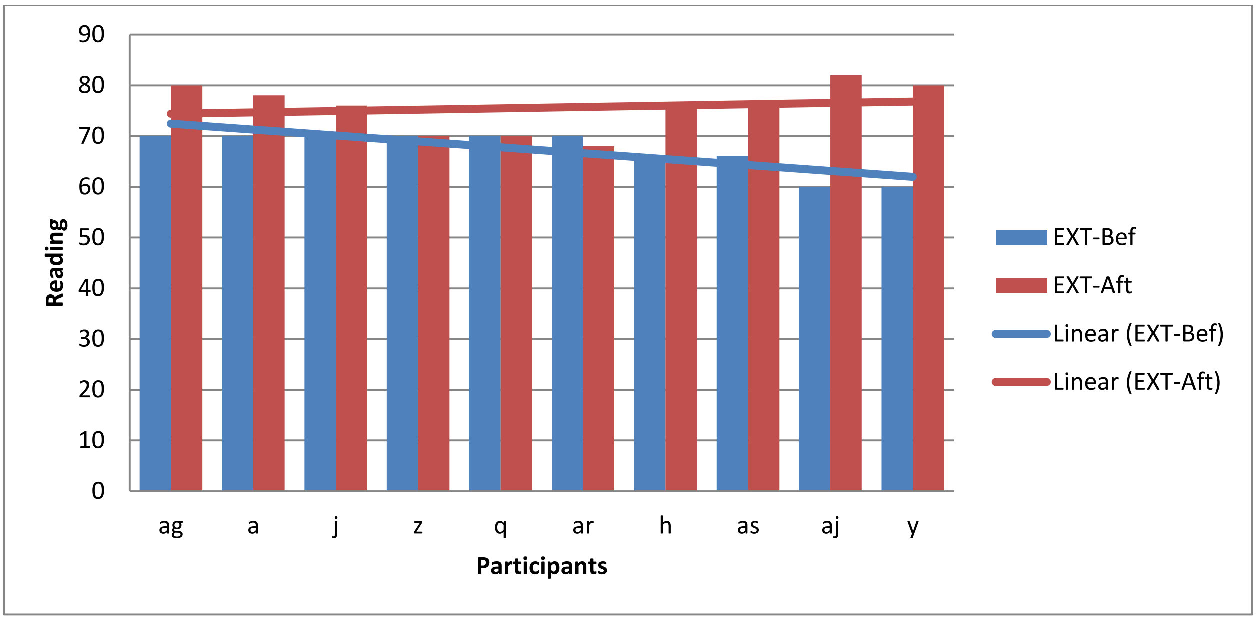


Figure 4.40 Pre–post cervical range of motion, extension, Age dependant, group B (26-30) (n=10) (p= 0.000538219)

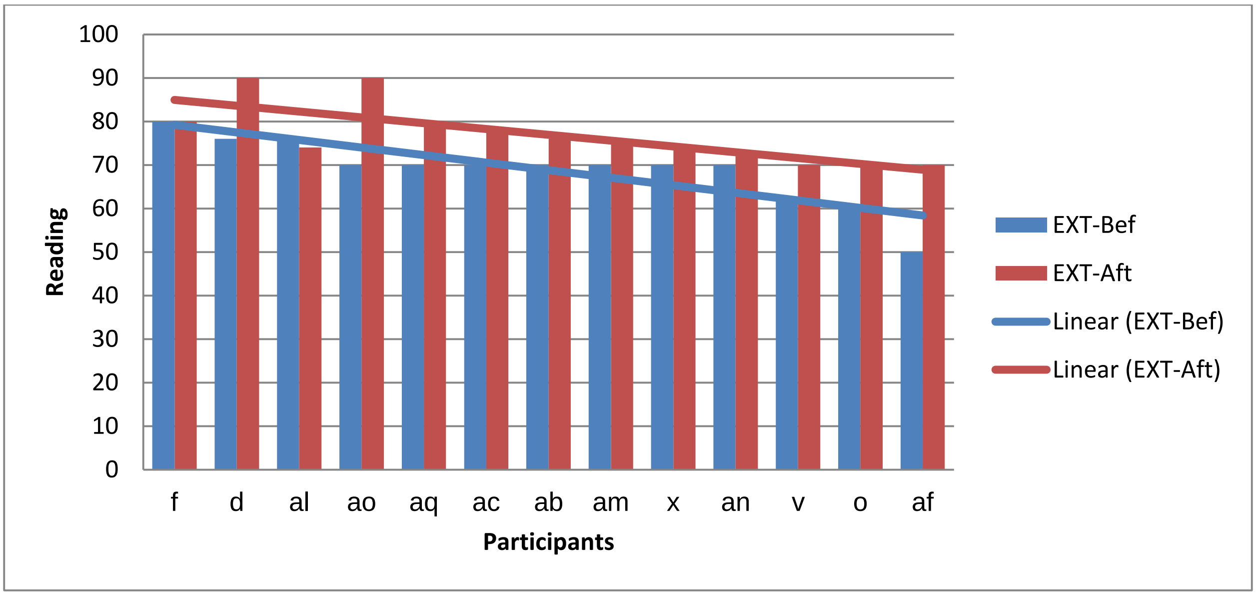


Figure 4.41 Pre-post cervical range of motion, extension, Age dependant, group C (31-45) (n=13) (p= 0.008570293)

P values extension- overall, gender, race and BMI (Table 4.3)

Overall p-value	**Sub-group**	**Number of participants (n=)**	***p*-value**	**BMI**	**Number of participants (n=)**	***p*- value**
0.0000002	M	18	0.000046	A	4	0.019041424
	F	27	0.00021	B	23	0.003170933
	W	29	0.00013	C	10	0.000204756
	B	7	0.015	D	8	0.071668896
	I	9	0.0135			

4.11.6 Cervical range of motion – Flexion – Overall

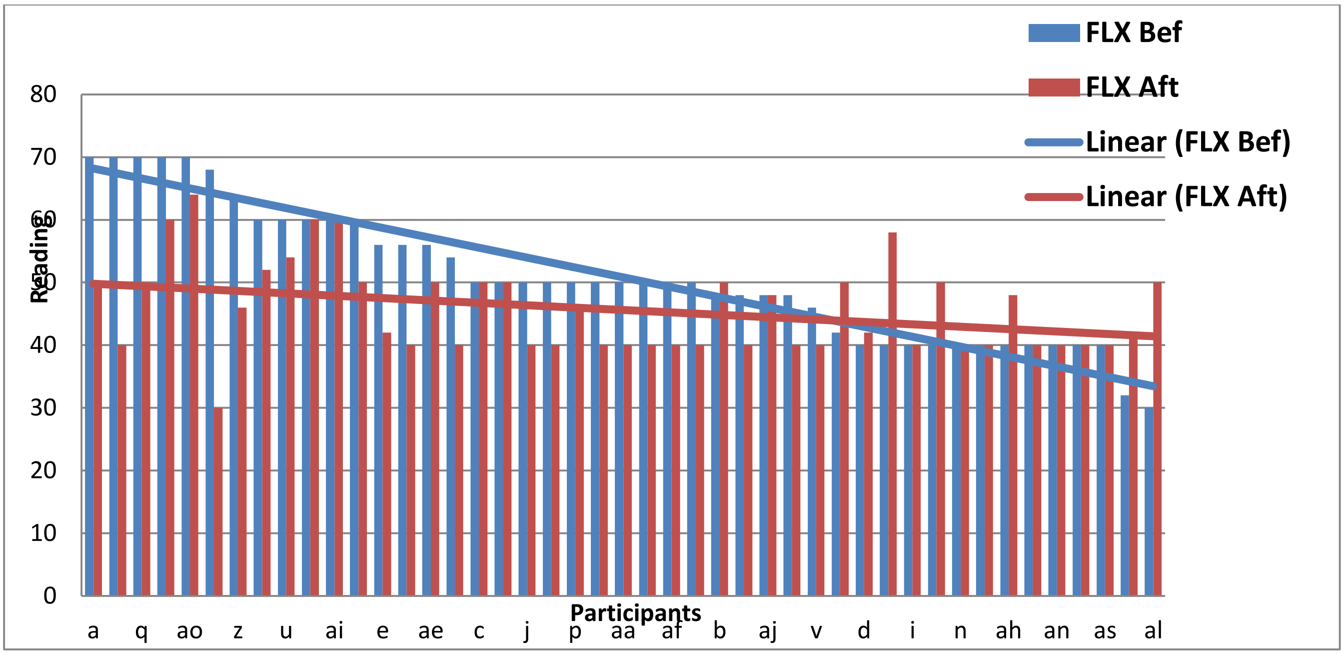


Figure 4.42 Pre-post cervical range of motion, flexion, (n=45) (p=0.008637)

Flexion results showed a significant decrease at conclusion of the study (*p*=<0.05). This is likely as a result of changes in the local cervical biomechanics. The DCF muscles are directly attached to the cervical spine and are considered the core stabilizers in the cervical spine (Jull and Sterling, 2008). When this muscle contracts it results in slight flattening of the cervical spine (Jull and Sterling, 2008). The muscular remodeling discussed in the extension range of motion previously, a new range of motion must be established in alignment with the flexor extensor synergy of the cervical spine (Liebenson, 2007).

It must be noted that despite the decrease in range of motion overall with regard to flexion, the ranges noted in pre / post assessment were in accordance with those stipulated by (Lewit,1991) which suggests the normal flexion range to be 43 degrees to 73 degrees. This was still demonstrated at conclusion of this study in the majority of participants.

4.11.7 Cervical range of motion – Flexion – Gender

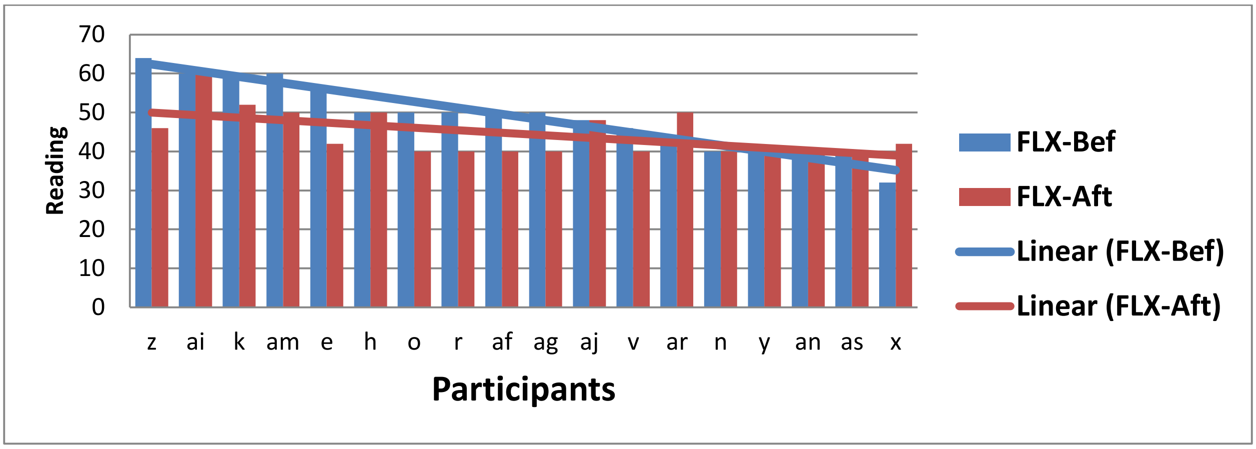


Figure 4.43 Pre–post cervical range of motion, flexion, male only (n=18) (*p*=0.093065)

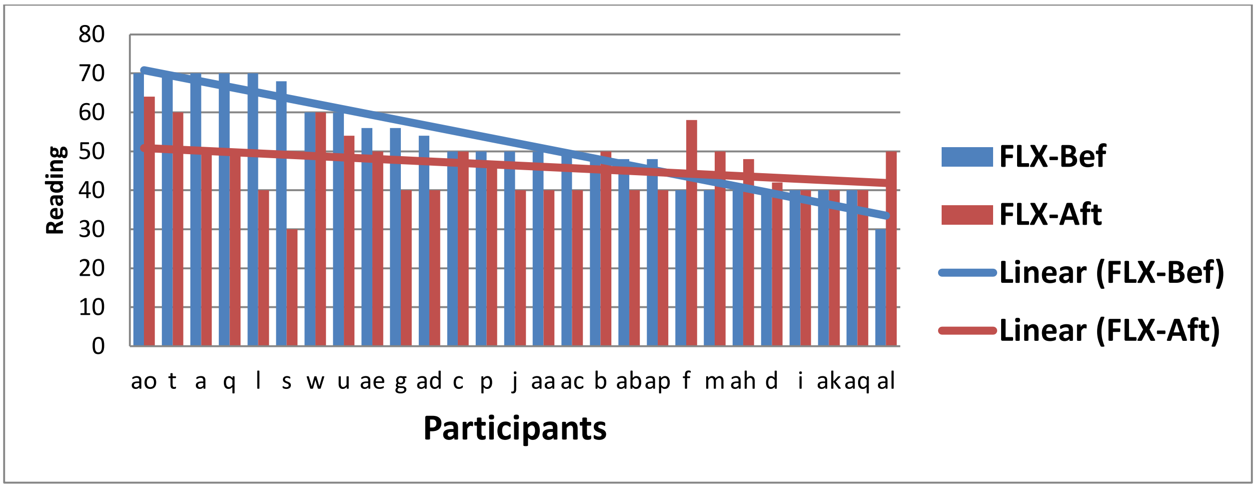


Figure 4.44 Pre–post cervical range of motion, flexion, female only (n=27) (*p*=0.041055)

4.11.8 Cervical range of motion – Flexion – Ethnicity

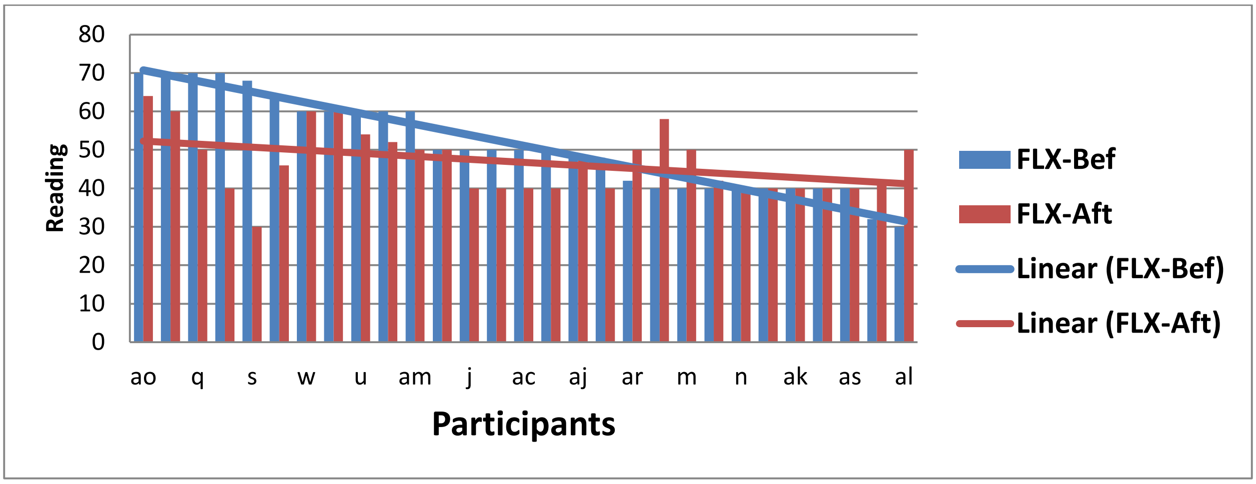


Figure 4.45 Pre–post cervical range of motion, flexion, white only (n=29) (*p*=0.119471)

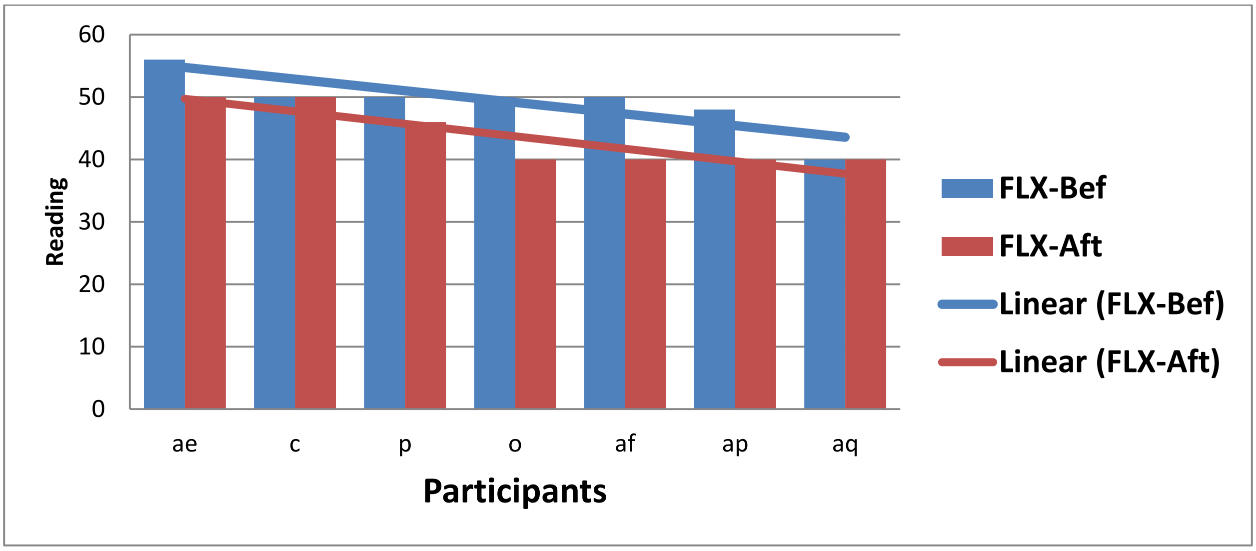


Figure 4.46 Pre–post cervical range of motion, flexion, Black only (n=7) (*p*=0.055115)

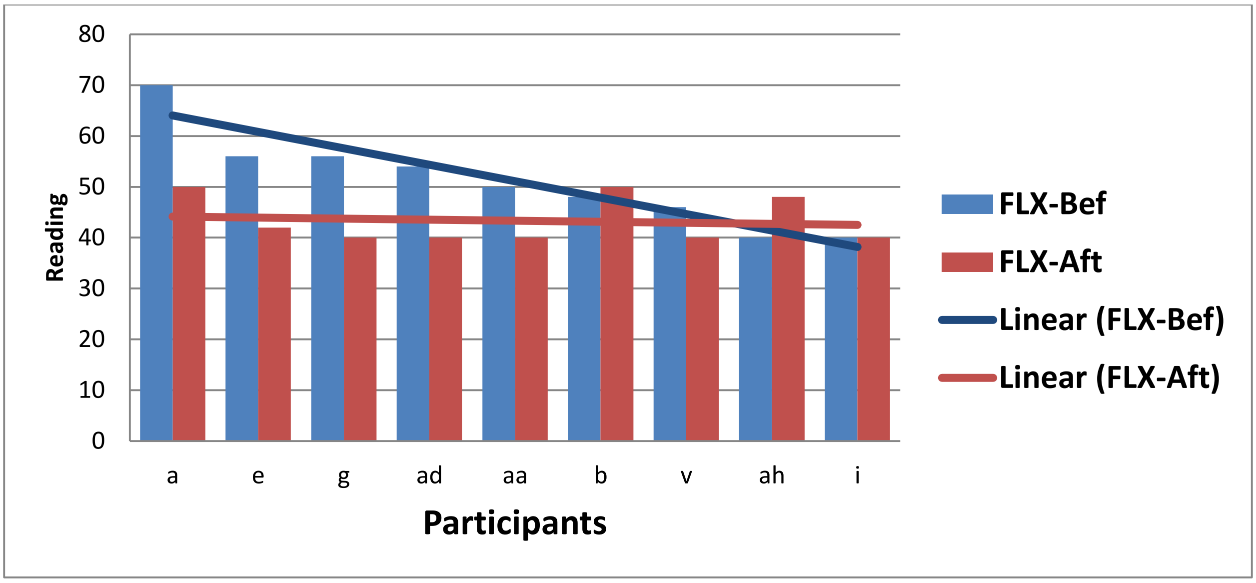


Figure 4.47 Pre–post cervical range of motion, flexion, Indian only (n=9) (*p*=0.022234)

4.11.9 Cervical range of motion – flexion – BMI

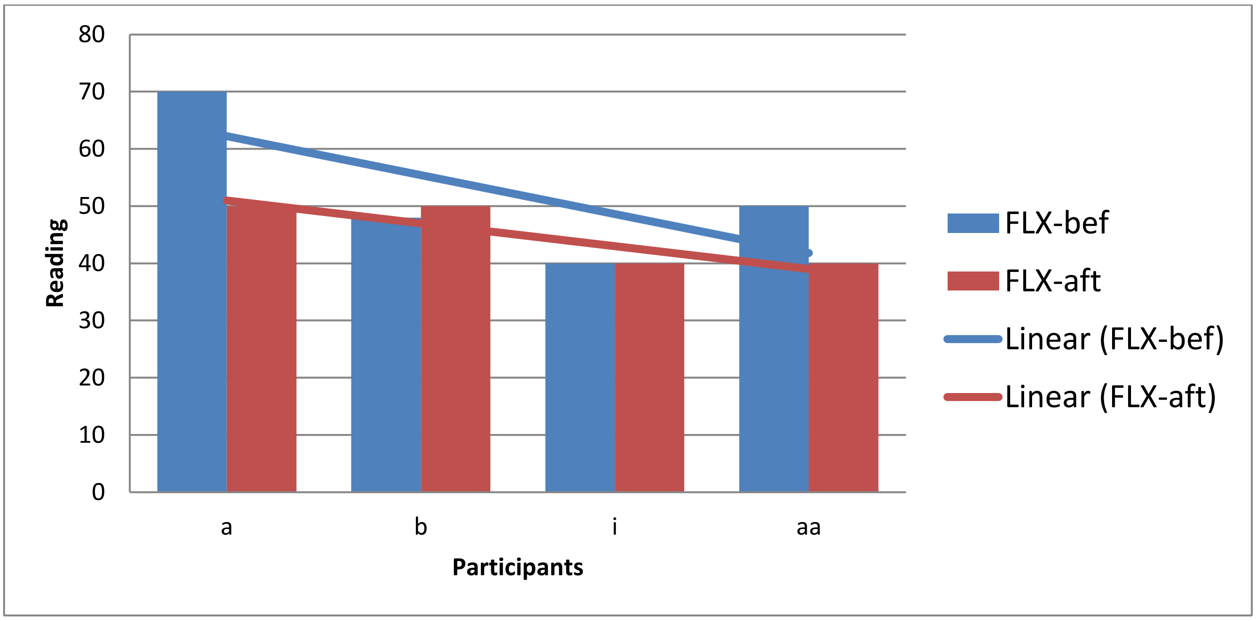


Figure 4.48 Pre–post cervical range of motion, flexion, BMI dependant, group A (<18.5) (n=4)

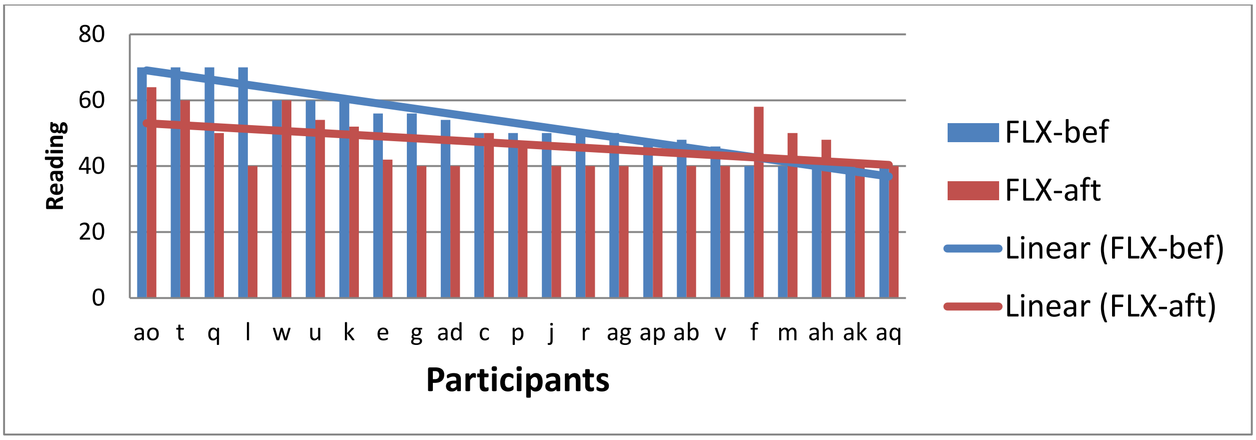


Figure 4.49 Pre–post cervical range of motion, flexion, BMI dependant, group B (18.5-24.9) (n=23)

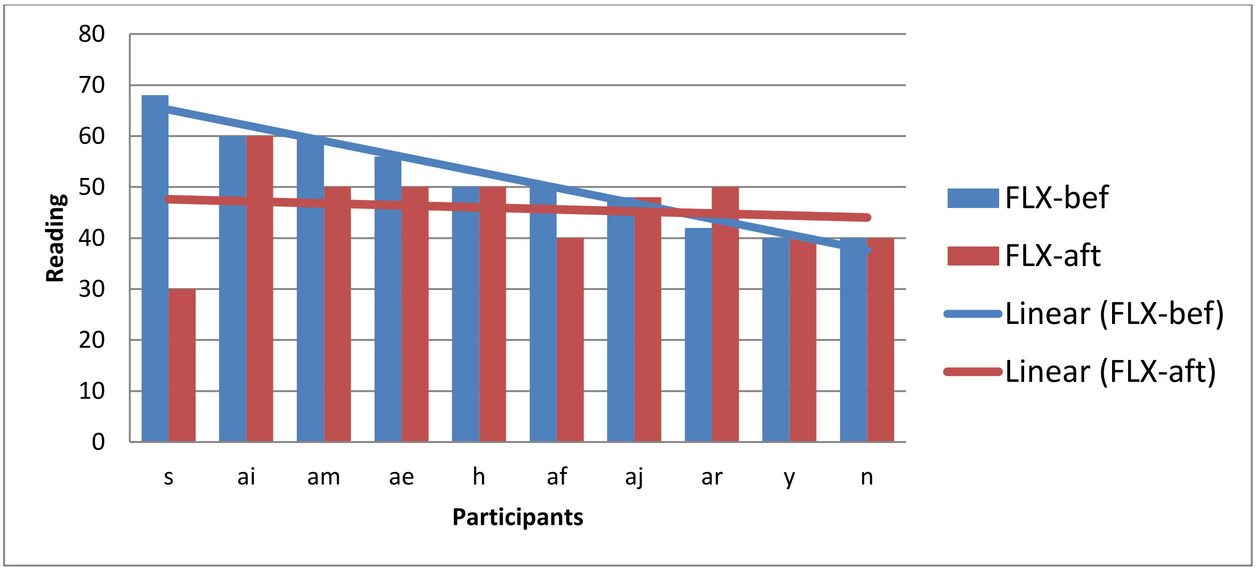


Figure 4.50 Pre–post cervical range of motion, flexion, BMI dependant, group C (25-29.9) (n=10)

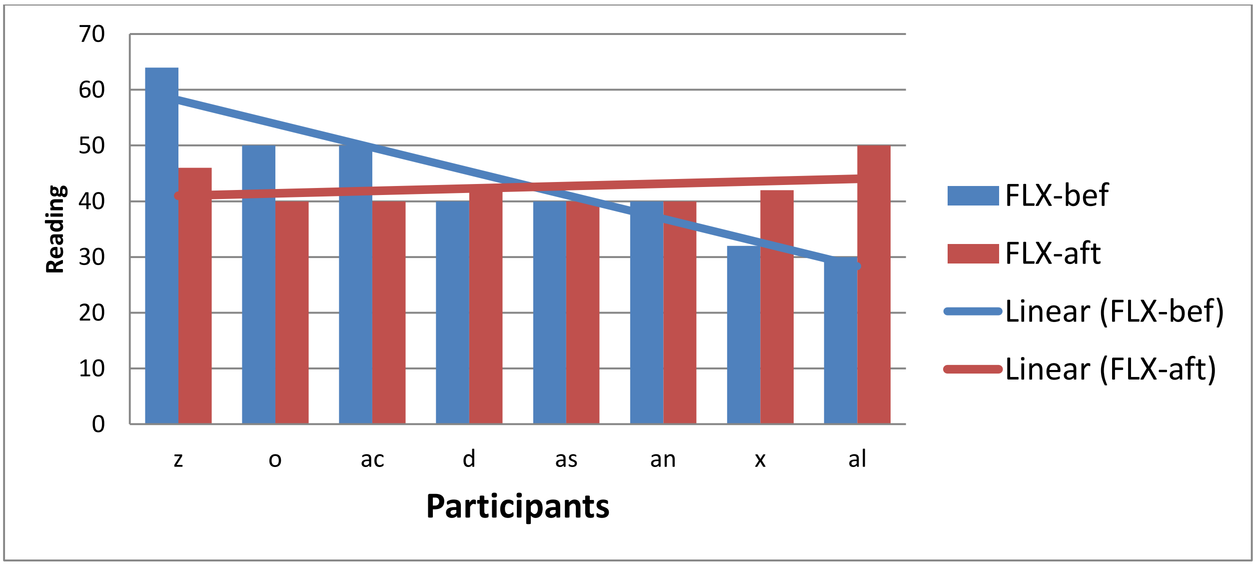


Figure 4.51 Pre–post cervical range of motion, flexion, BMI dependant, group D (>30) (n=8)

4.11.10 Cervical range of motion – Flexion – Age

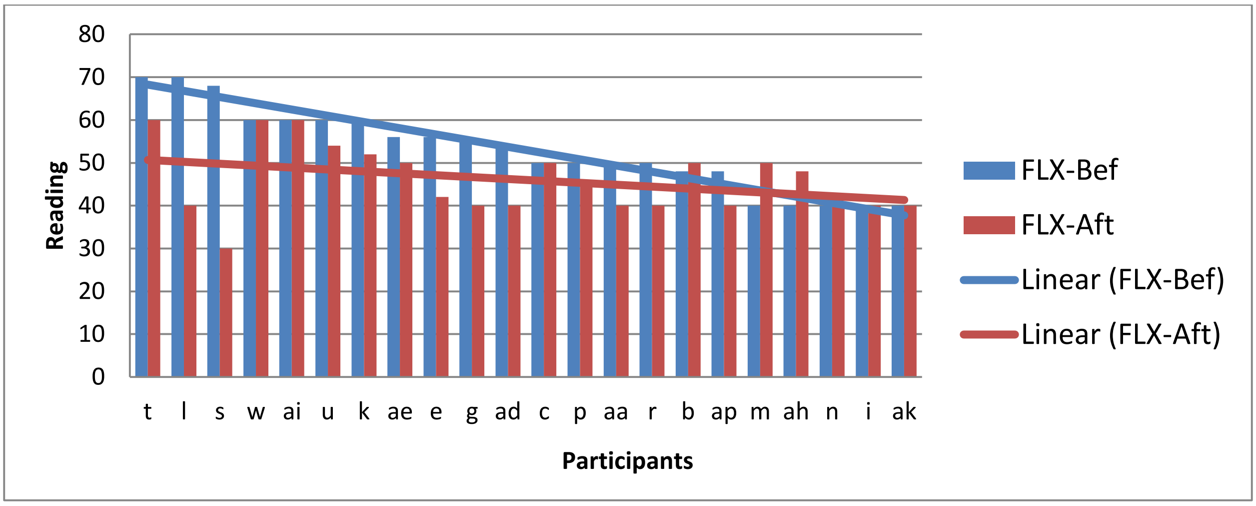


Figure 4.52 Pre/post results, flexion, age group A (19-25) (n=22) (*p*=0.012422136)

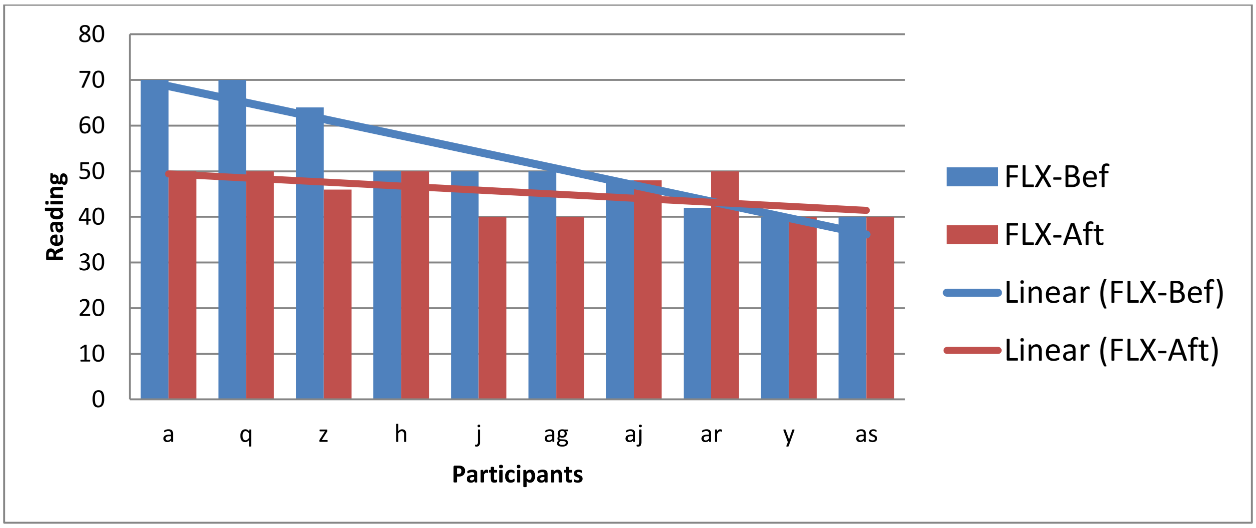


Figure 4.53 Pre/post results, flexion, age group B (26-30) (n=26-30) (*p*=0.102884556)

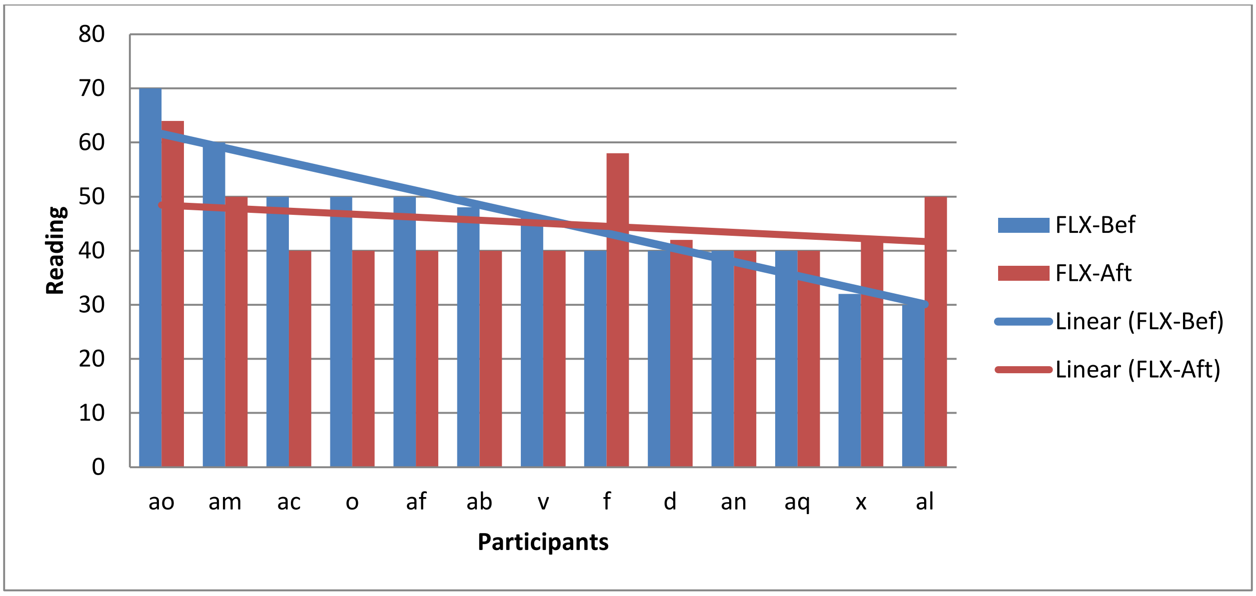


Figure 4.54 Pre/post results, age group C (31-45) (n=13) (*p*=0.839317088)

Flexion p-values including overall, gender, ethnicity and BMI and age (Table 4.4)						
Overall p-value	**Sub-group**	**Number of participants (n=)**	***p*-value**	**BMI**	**Number of participants (n=)**	***p*- value**
0.00864	M	18	0.093	A	4	0.373900966
	F	27	0.041	B	23	0.026000858
	W	29	0.1194	C	10	0.177939999
	B	7	0.0551	D	8	0.859508537
	I	9	0.0444			

4.11.11 Cervical range of motion – Right Rotation – Overall

Rotation left and right both showed statistically significant results showing that range of motion did improve at conclusion of the study.

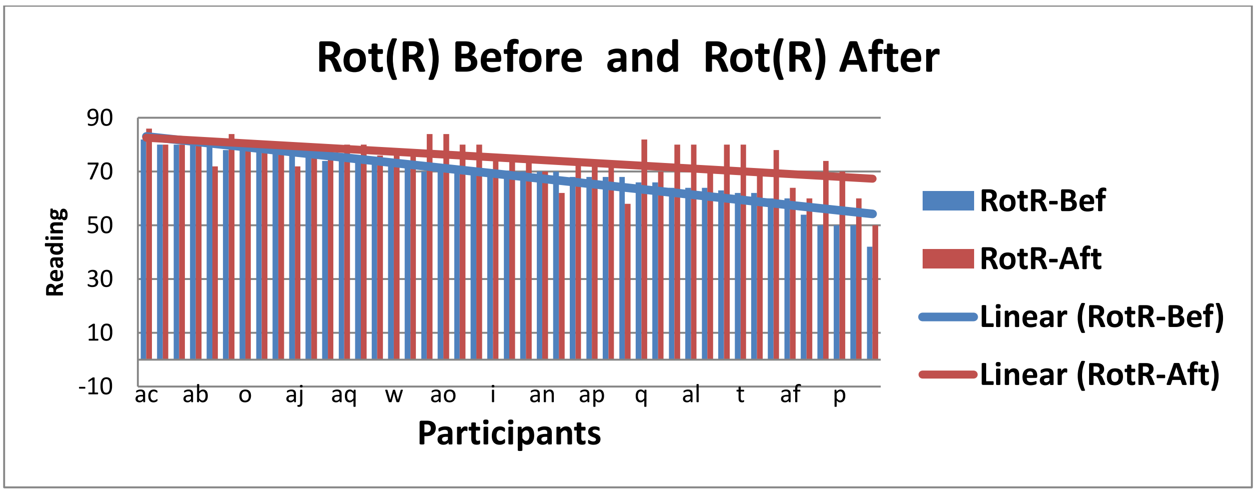


Figure 4.55 Pre/post overall results, range of motion, Rot R, (*p*=0.00063)

Cervical range of motion in terms of rotation toward the left and right did show statistically significant improvement (p=<0.005). The improved local cervical rotation is likely as a result of an increase in local cervical core stability as described a previousl (Jull and Sterling, 2008). Also the DCF musculature assists in active rotation of the cervical spine (Liebenson, 2007; Moore and Dalley, 1999), thus improved functioning of these muscles is likely to add to the local range of motion available.

4.11.12 Cervical range of motion – Right Rotation – Gender

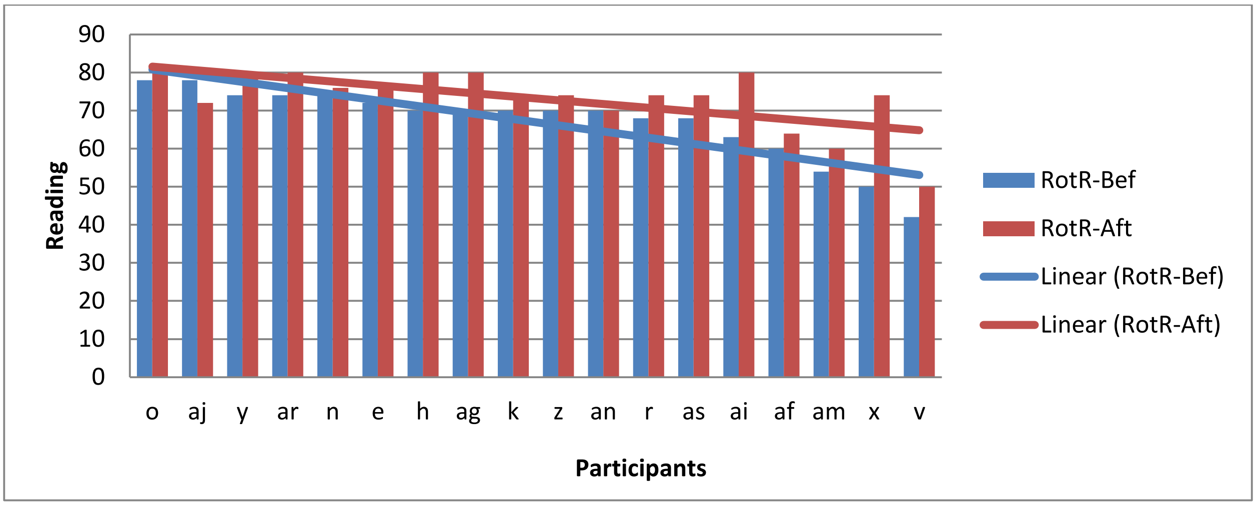


Figure 4.56 Pre/post results, range of motion, Rot R, male only (*p*= 0.0427152)

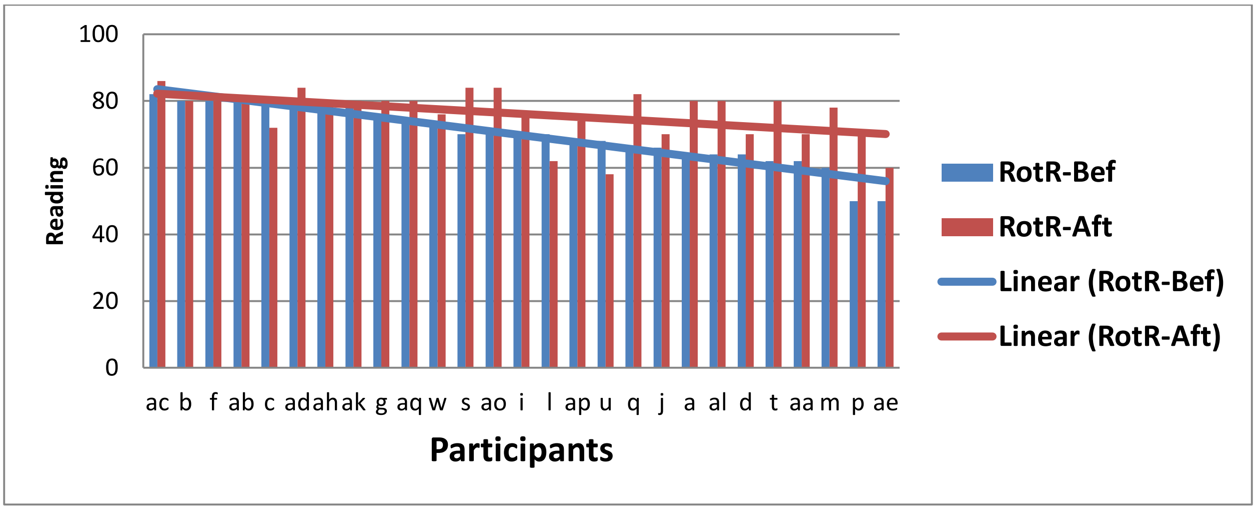


Figure 4.57 Pre/post results, range of motion, Rot R, female only (*p*=0.0056396)

4.11.13 Cervical range of motion – Right Rotation – Ethnicity

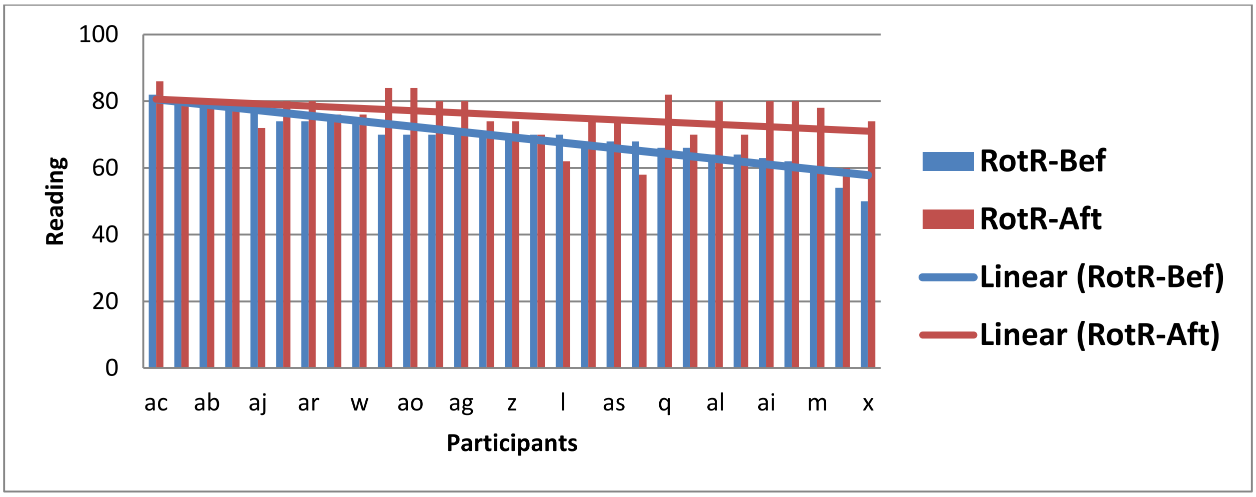


Figure 5.58 Pre/post results, range of motion, Rot R, White only (*p*=0.00088)

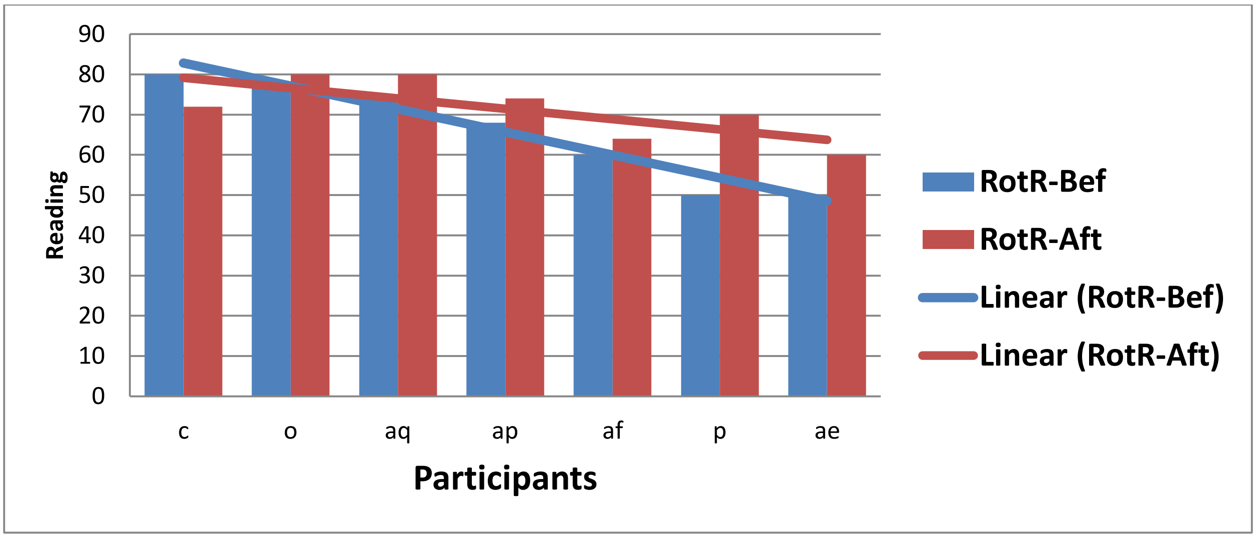


Figure 4.59 Pre/post results, range of motion, Rot R, Black only (*p*=0.328068)

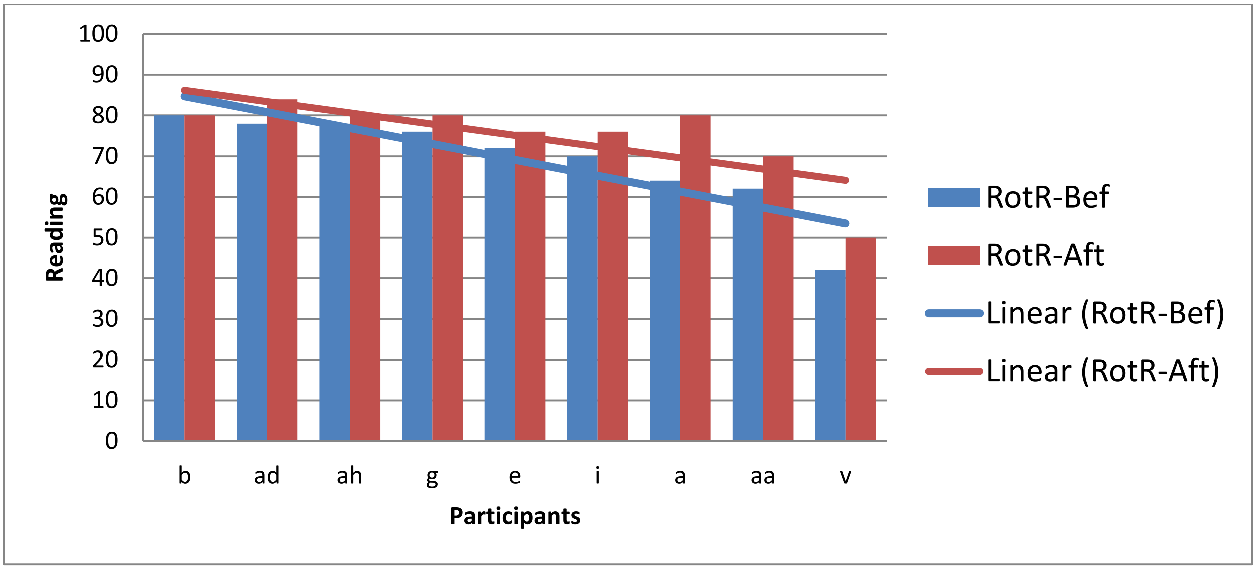


Figure 4.60 Pre/post results, range of motion, Rot R, Indian only (*p*=0.26913)

4.11.14 Cervical range of motion -– Right Rotation – BMI

These results were analysed by the statistician and found to be insignificant (>0.005) and hence not included in this chapter, as with some other BMI related results that are discussed earlier on in the chapter**.**

4.11.15 Cervical range of motion -– Right Rotation – Age

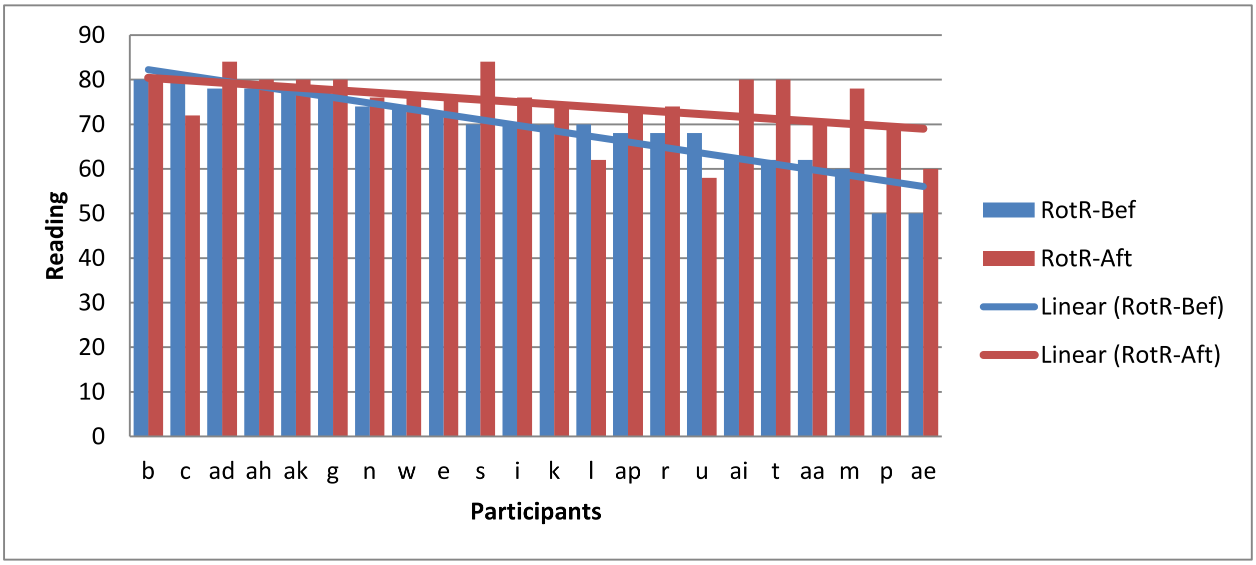


Figure 4.61 Pre/post results, range of motion, Rot R, age group A (19-25) (n=22)

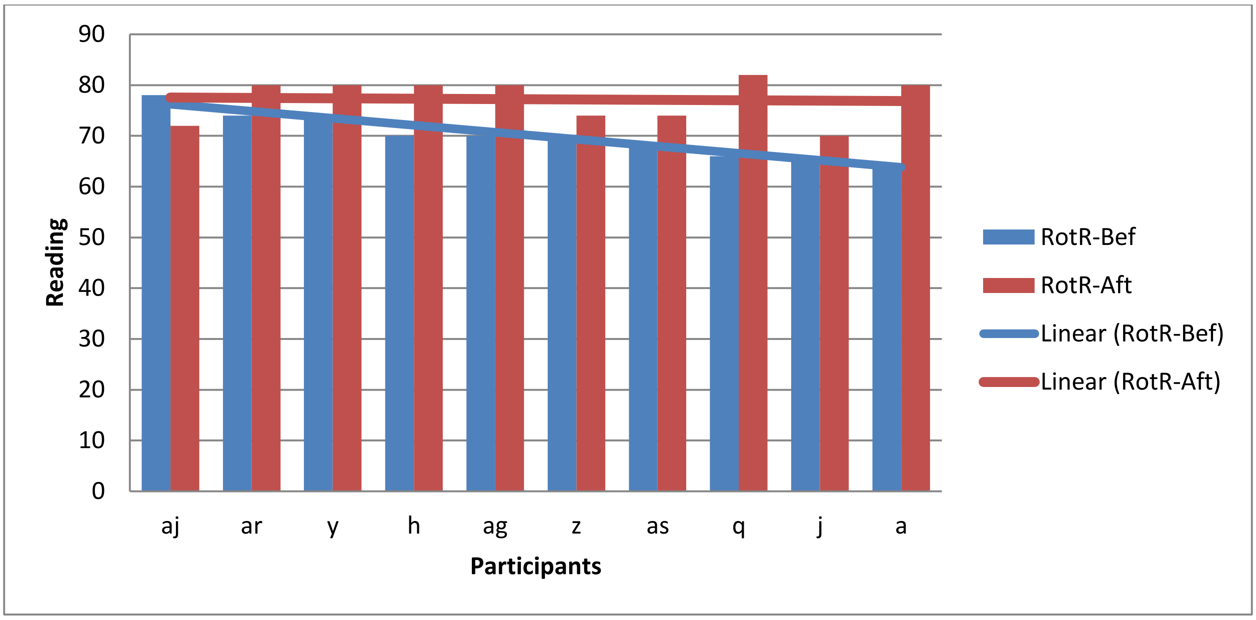


Figure 4.62 Pre/post results, range of motion, Rot R, age group B (26-30) (n=10)

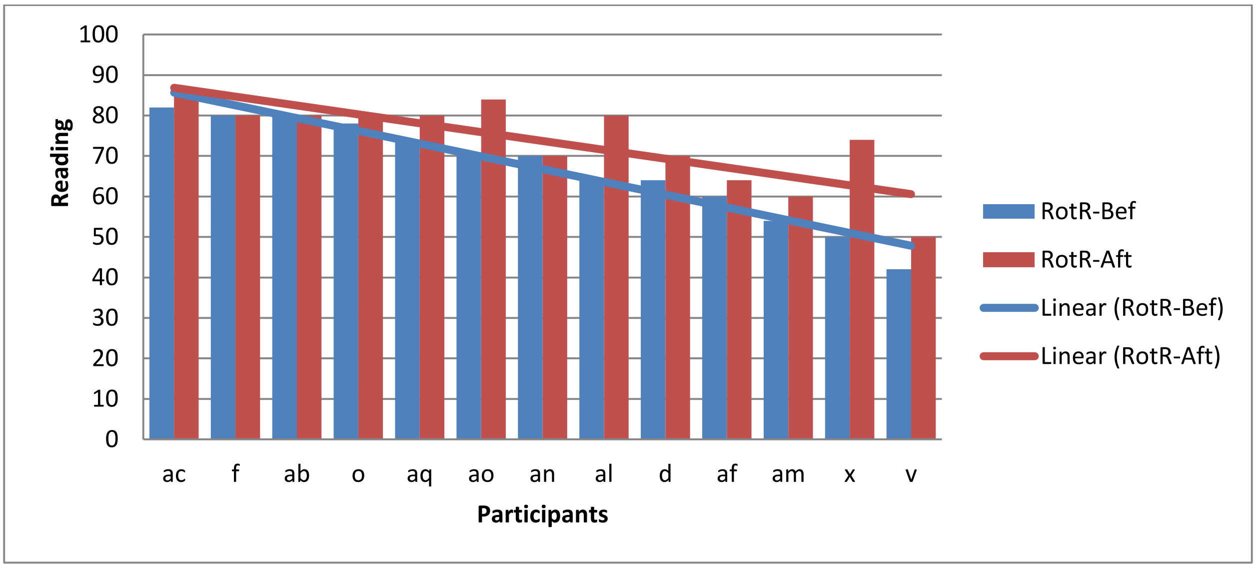


Figure 4.63 Pre/post results, range of motion, Rot R, age group C (31-45) (n=13)

P values rotation right- overall, gender, race and age (Table 4.5)

Overall p-value	**Sub-group**	**Number of participants (n=)**	***p*-value**	**age**	**Number of participants (n=)**	***p*- value**
0.00063	M	18	0.0427	A	22	0.02342
	F	27	0.00563	B	10	0.00143
	W	29	0.00088	C	13	0.1416
	B	7	0.328			
	I	9	0.2691			

Age group C has shown an insignificant *p* value when compared to group C age values in other ranges of motion. This may be as a result of age related degeneration in the cervical spine and in the surrounding cervical soft tissue.

In older adults one of the most noted postural transformations is more pronounced FHP, accentuated thoracic curve and loss of the normal lumbar lordosis (Bergmann et al, 2005; Haldeman 2005; Kendall et al 2005; Jull *et al*, 2008). This will have a pronounced effect on both range of motion and the craniovertebral angle in the seated and standing positions. This is discussed earlier in the chapter.

4.11.16 Cervical range of motion – Left Rotation – Overall

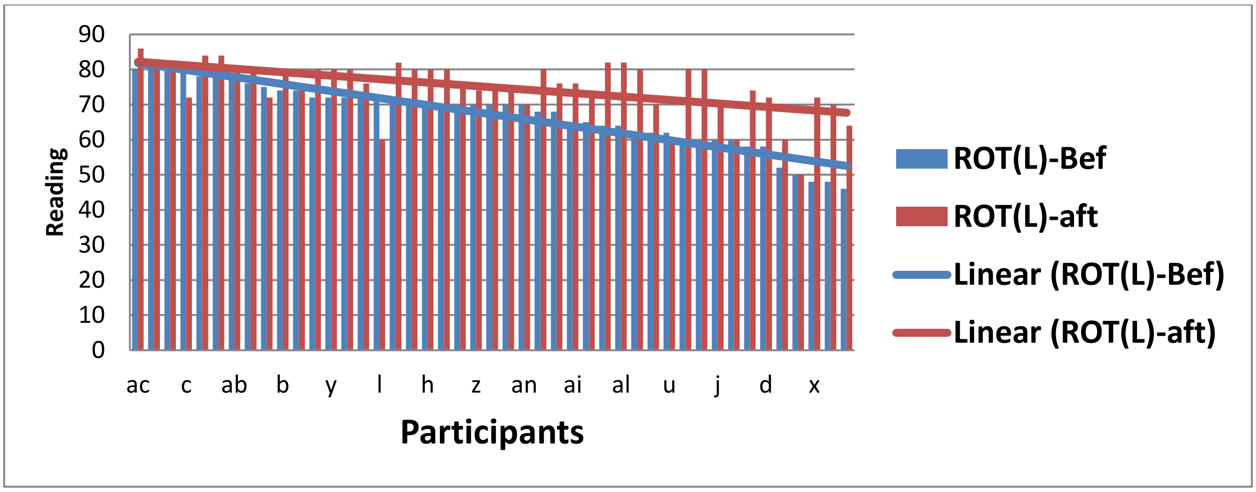


Figure 4.64 Pre/post overall results, range of motion, rotation left (n=45) (*p*=0.00003)

4.11.17 Cervical range of motion – Left Rotation – Gender

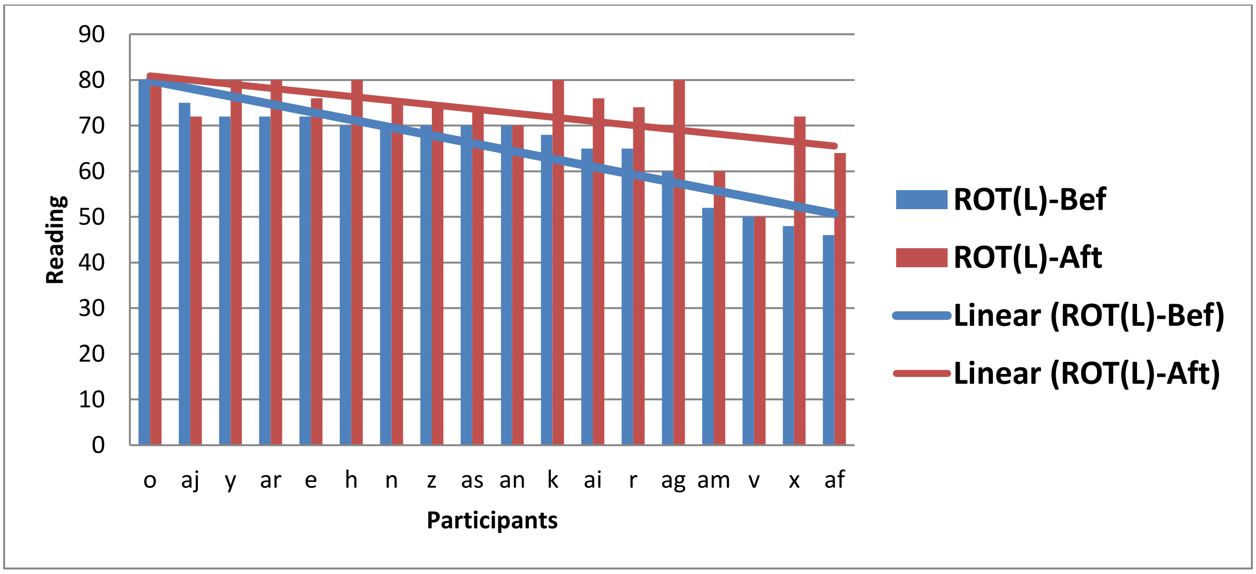


Figure 4.65 Pre/post results, range of motion, rotation left, male only (n=18) (*p*=0.012792)

Rotation toward the left showed improvement although this improvement was insignificant (p=0.0128) (p=>0.005). As mentioned earlier in the chapter it is important to remember that although the range of motion for rotation toward the left has proven statistically insignificant, the overall range of motion is still within normal limits according to (Lewit, 1991) (60-86 degrees) for the majority of participants.

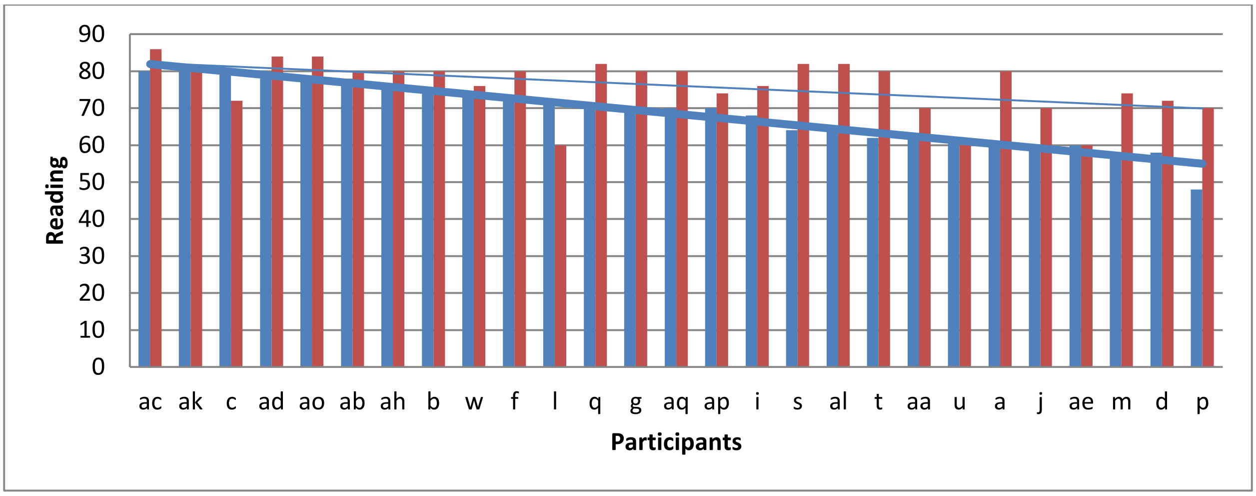


Figure 4.66 Pre/post results, range of motion, rotation left, female only (n=27) (*p*=0.00083273)

4.11.18 Cervical range of motion – Left Rotation – Ethnicity

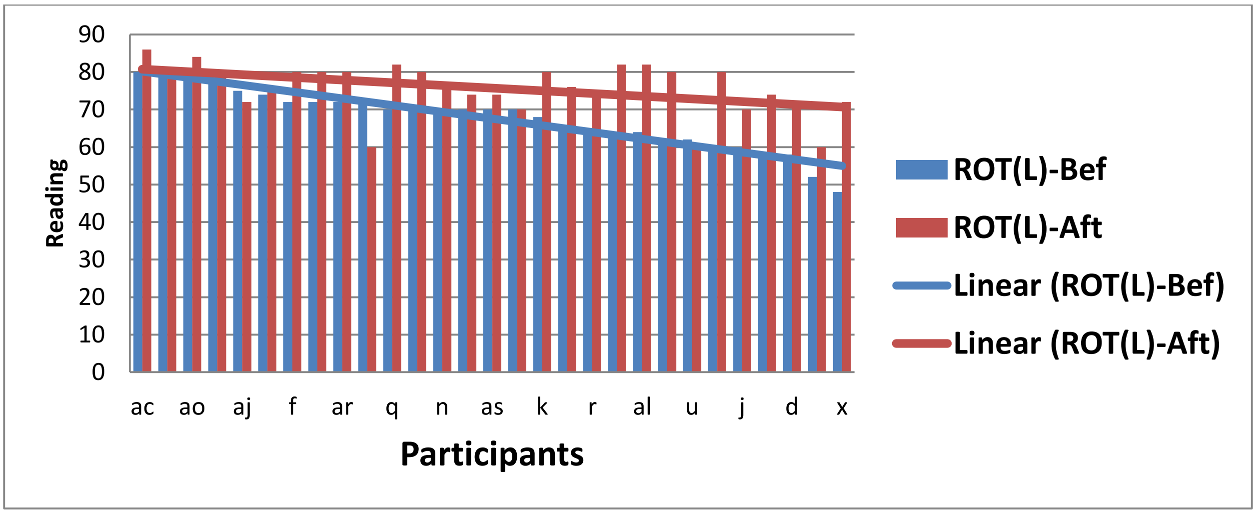


Figure 4.67 Pre/post results, range of motion, rotation left, White only (n=29) (*p*=0.000100)

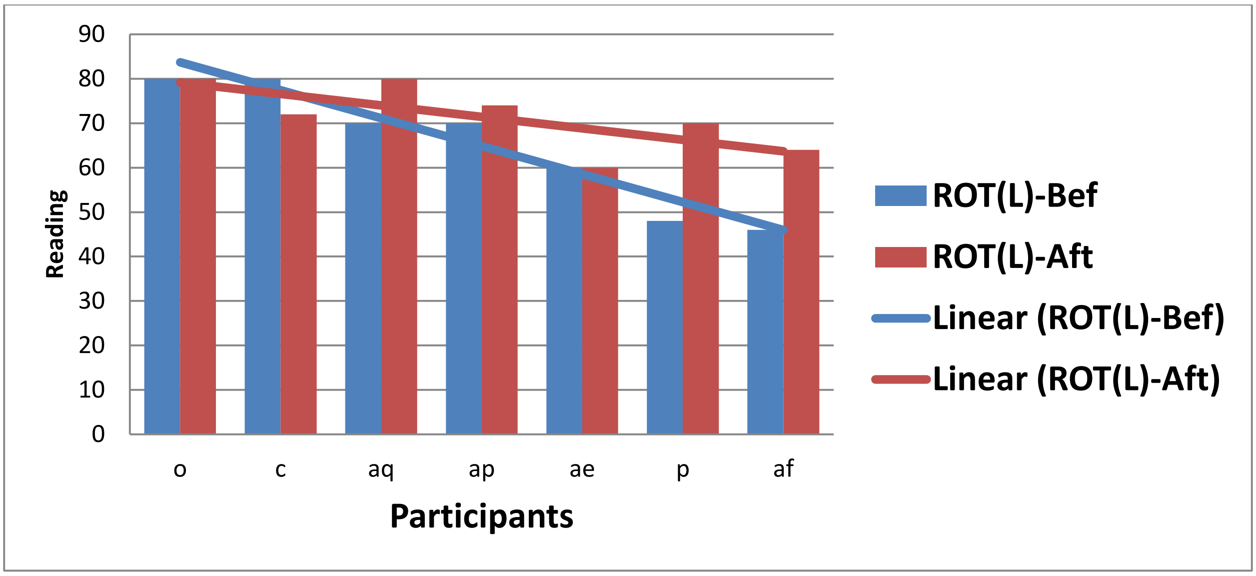


Figure 4.68 Pre/post results, range of motion, rotation left, Black only (n=7) (*p*=0.302541)

Ethnic variation has also shown significantly poor results. This has proven to be a weakness in the study. These ethnic groups are not evenly distributed and hence have shown adverse results where statistical significance is concerned (*p*=>0.005).

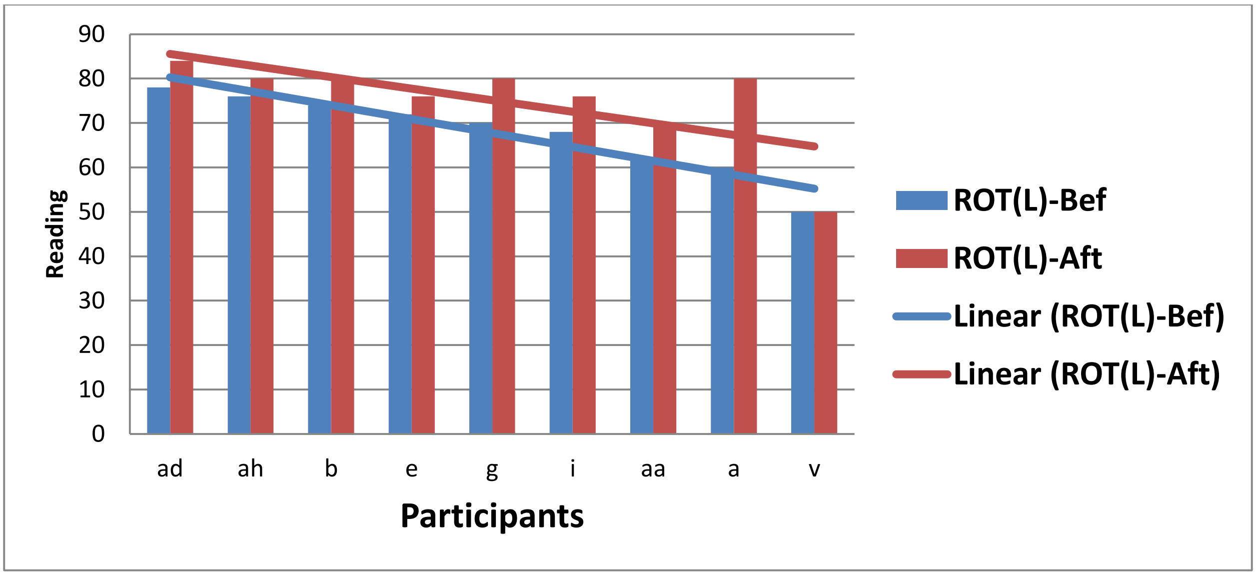


Figure 4.69 Pre/post results, range of motion, rotation left, Indian only (n=7) (*p*=0.124897)

4.11.19 Cervical range of motion – Left Rotation – BMI

BMI dependant range of motion was statistically analysed, the results were found to be insignificant, therefore the graph analysis has not been added into the chapter. This was further discussed previously.

4.11.20 Cervical range of motion – Left Rotation – Age

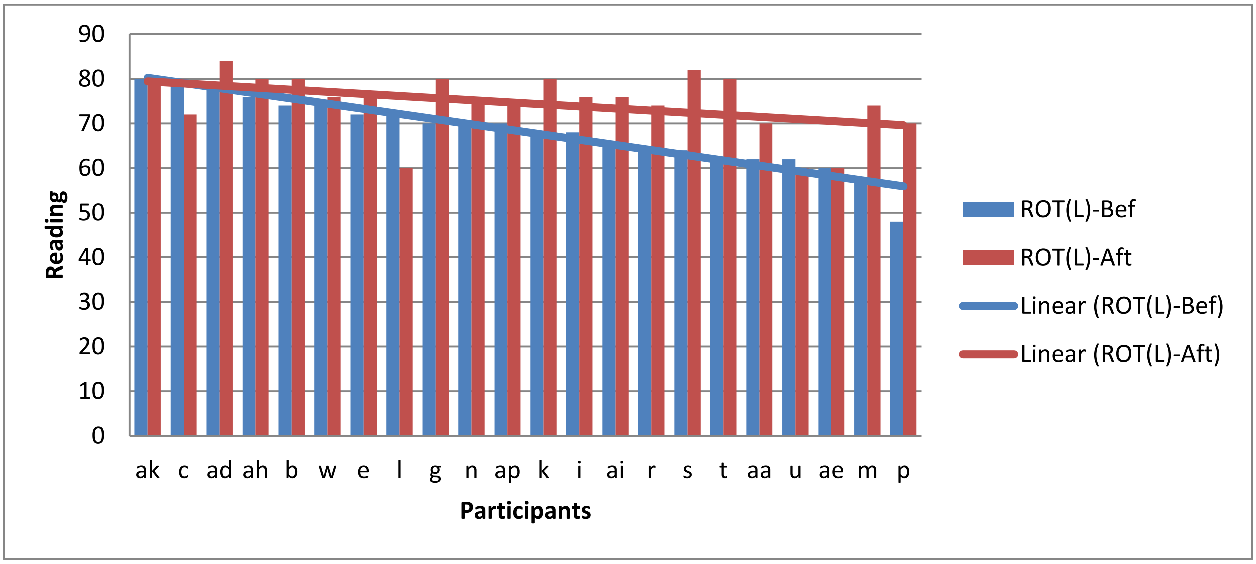


Figure 4.70 Pre/post overall results, range of motion, rotation left, age dependant , group A (19-25) (n=22) (*p*= 0.006)

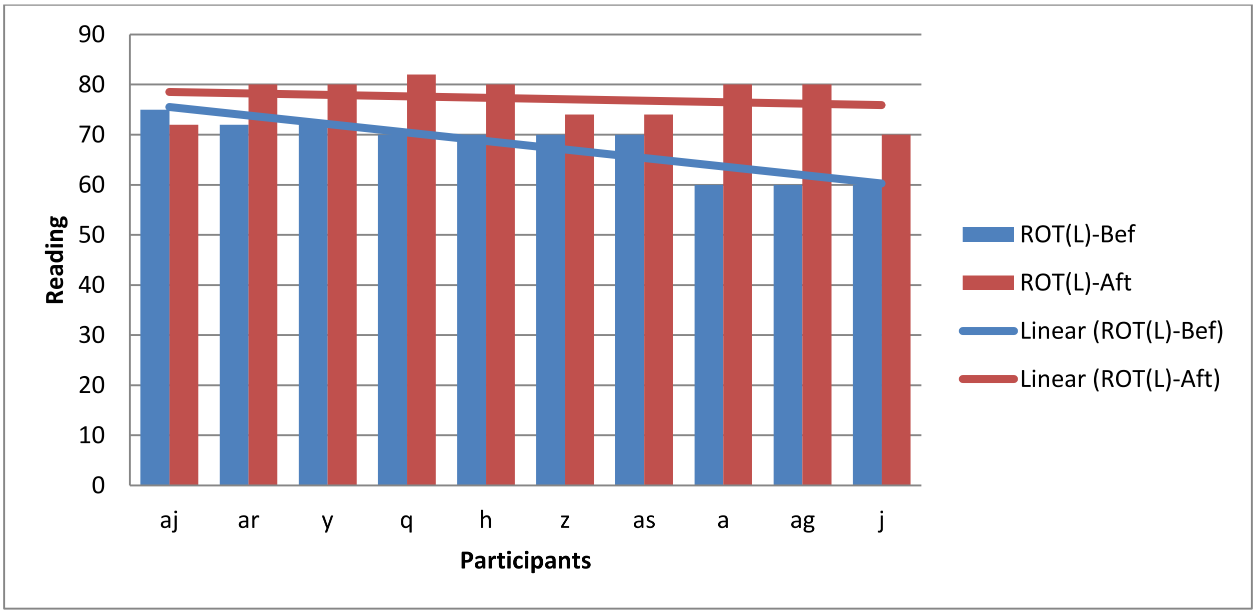


Figure 4.71 Pre/post overall results, range of motion, rotation left, age dependant, group B (26-30)(n=10) (*p*= 0.00066)

Rotation toward the left in the age group C range (31-45) was statistically analysed and the results were proven insignificant (*p*=<0.005), and therefore the graph has not been included into the chapter.

P values rotation left- overall, gender, race and age (Table 4.6)

Overall *p*-value	**Sub-group**	**Number of participants (n=)**	***p*-value**	**age**	**Number of participants (n=)**	***p*- value**
0.00003	M	18	0.01279	A	22	*p*= 0.006
	F	27	0.00083	B	10	*p*= 0.00066
	W	29	0.0001	C	13	*p*=0.1579
	B	7	0.3025			
	I	9	0.1249			

4.11.21 Cervical range of motion – Right Lateral Flexion – Overall

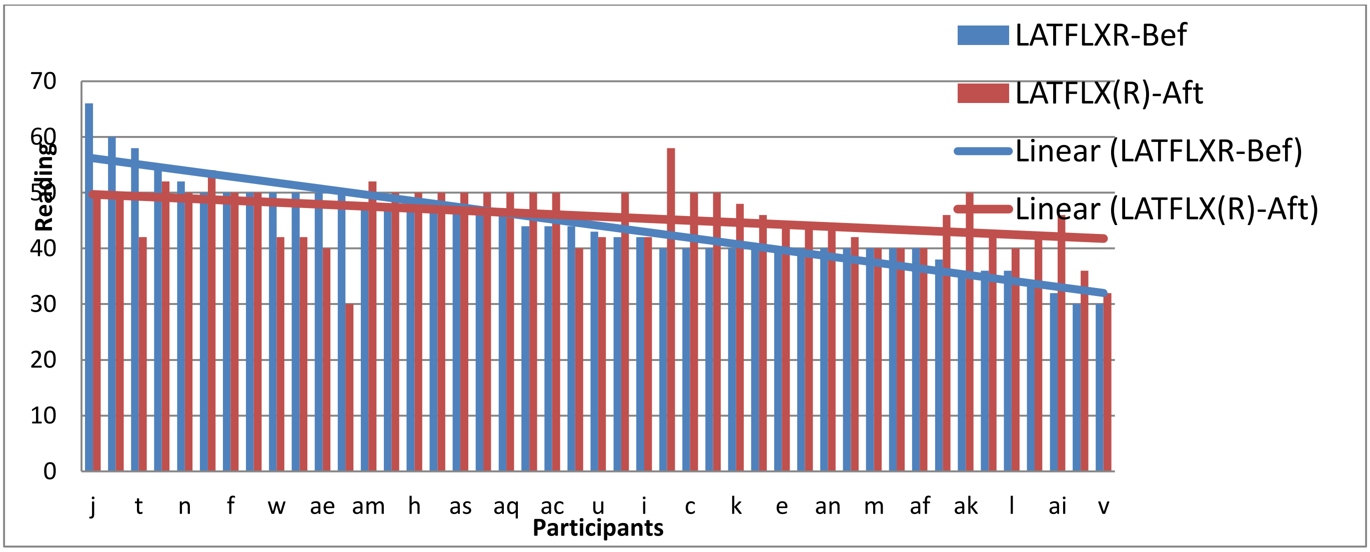


Figure 4.72 Pre/post overall results, lateral flexion right (n-45) (*p*=0.249847)

Lateral flexion showed results that were insignificant (*p*=>0.005). Hand dominance is one factor to consider (Shih and Kao, 2011), and is discussed later in the chapter. Another factor is that again, according to (Lewit, 1997), the lateral flexion ranges are within the normal limits at conclusion of the study (41-54 degrees).

4.11.22 Cervical range of motion – Right Lateral Flexion – Gender

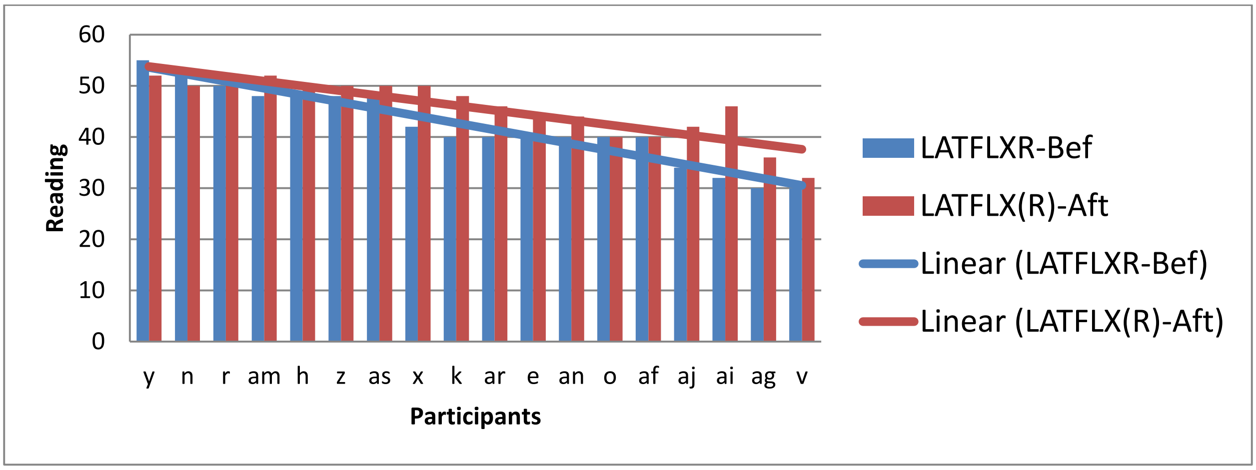


Figure 4.73 Pre/post results, lateral flexion right, male only (n=18) (*p*=0.114414).

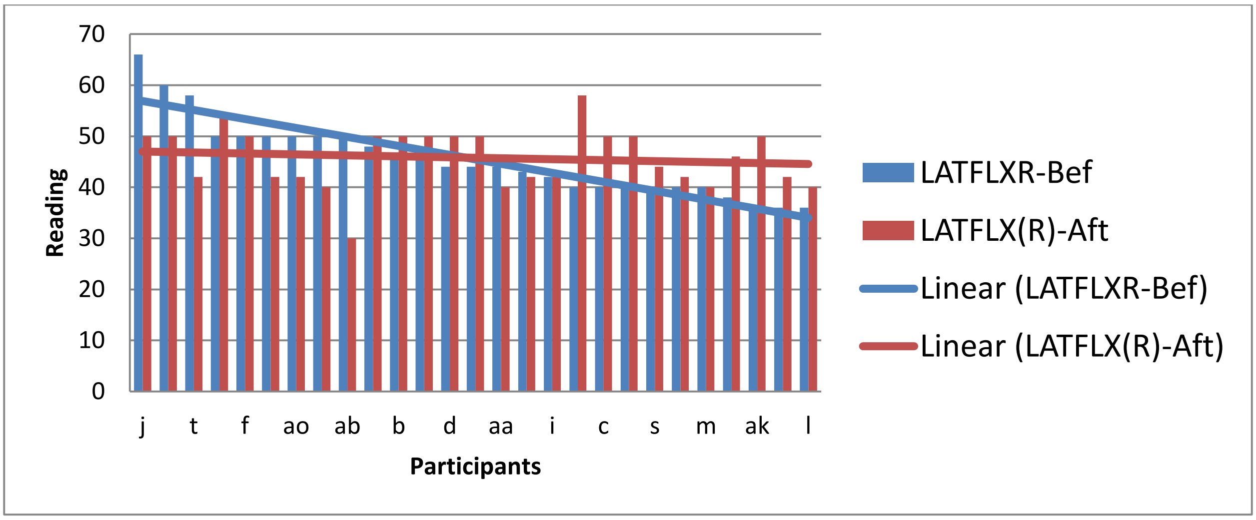


Figure 4.74 Pre/post overall results, lateral flexion right, female only (n=27) (*p*=0.856108)

4.11.23 Cervical range of motion – Right Lateral Flexion – Ethnicity

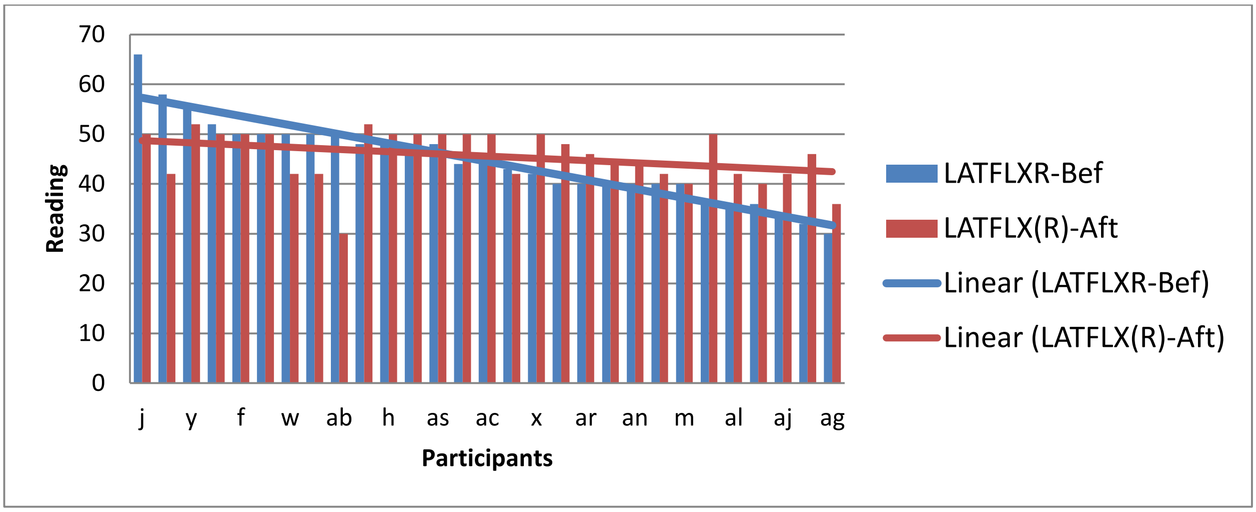


Figure 4.75 Pre/post overall results, lateral flexion right, White only (n=29) (*p*=0.542706)

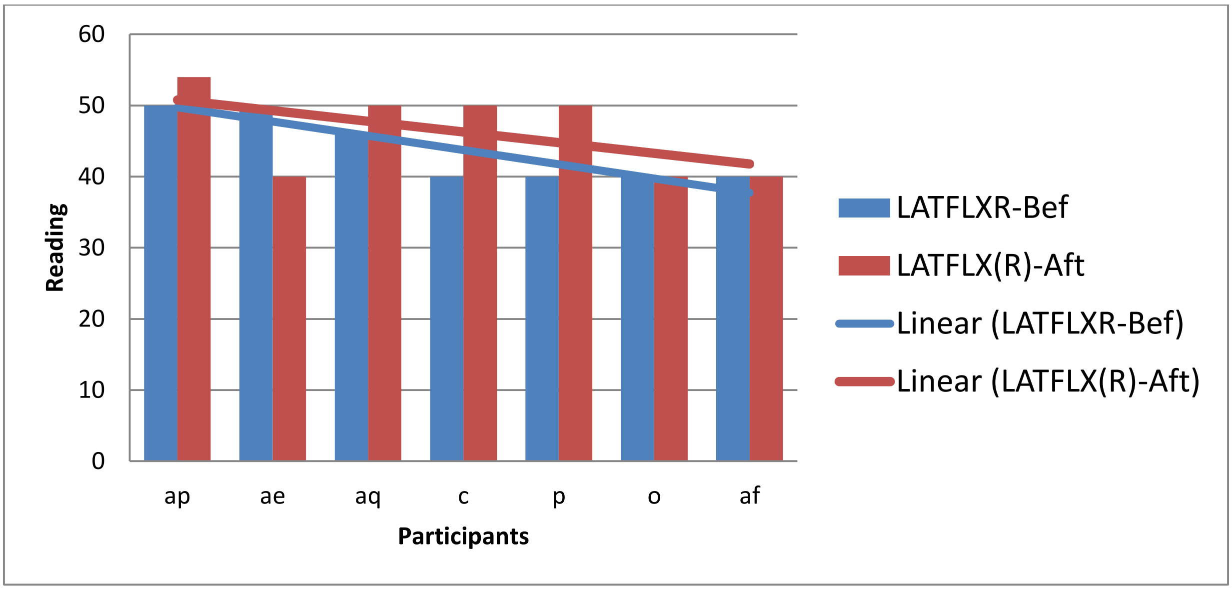


Figure 4.76 Pre/post overall results, lateral flexion right, Black only (n=7) (*p*=0.397829)

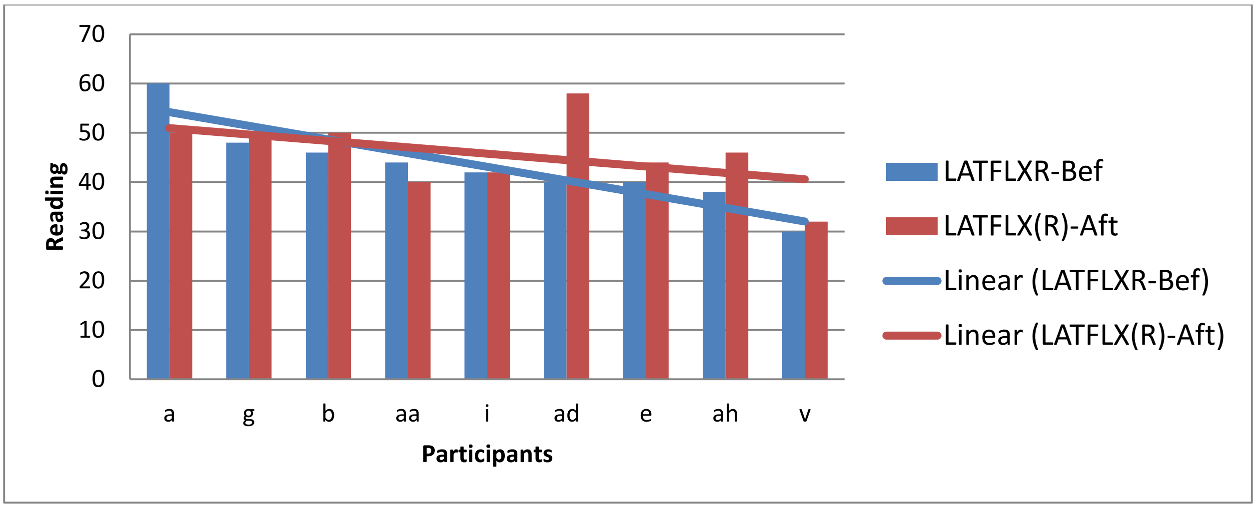


Figure 4.77 Pre/post overall results, lateral flexion right, Indian only (n=9) (*p*=0.48033)

4.11.24 Cervical range of motion – Right Lateral Flexion – BMI and age

Right lateral flexion dependant on BMI and age was statistically analysed and the results were proven insignificant (*p*=<0.005), therefore the respective graphs have not been added into the chapter.

Right lateral flexion results have shown to have presented with the worst results in the study. After careful scrutiny of the results it may be assumed that hand dominance may have influenced this (Liebenson, 2007 In a study done by Shih and Kao, (20011) (*p*=0.001) it was found that participants dominant hands demonstrated a significant posterior scapular tilt on the ipsilateral side having a biomechanical effect on the scapular extensors particularly the levator scapular. As described in chapter two this muscle influences cervico-scapular biomechanics significantly having an effect on the head posture (Shih and Kao, 20011). This may affect biomechanics in the cervical spine hence negatively impacting the improvement of lateral flexion to the right in the cervical spine. This is also notable, and consistent, although less so in rotation toward the right although these results were still statistically significant (*p*=<0.005). It can be assume that these results are hence justifiable on these findings.

P values right lateral flexion, overall and gender (Table 4.7)

Overall *p*-value	Sub-group	Number of participants (n=)	*p*-value
0.0145	M	18	0.01077
	F	27	0.3409
	W	29	0.1239
	B	7	0.3108
	I	9	0.0867

4.11.25 Cervical range of motion – Left Lateral Flexion – Overall

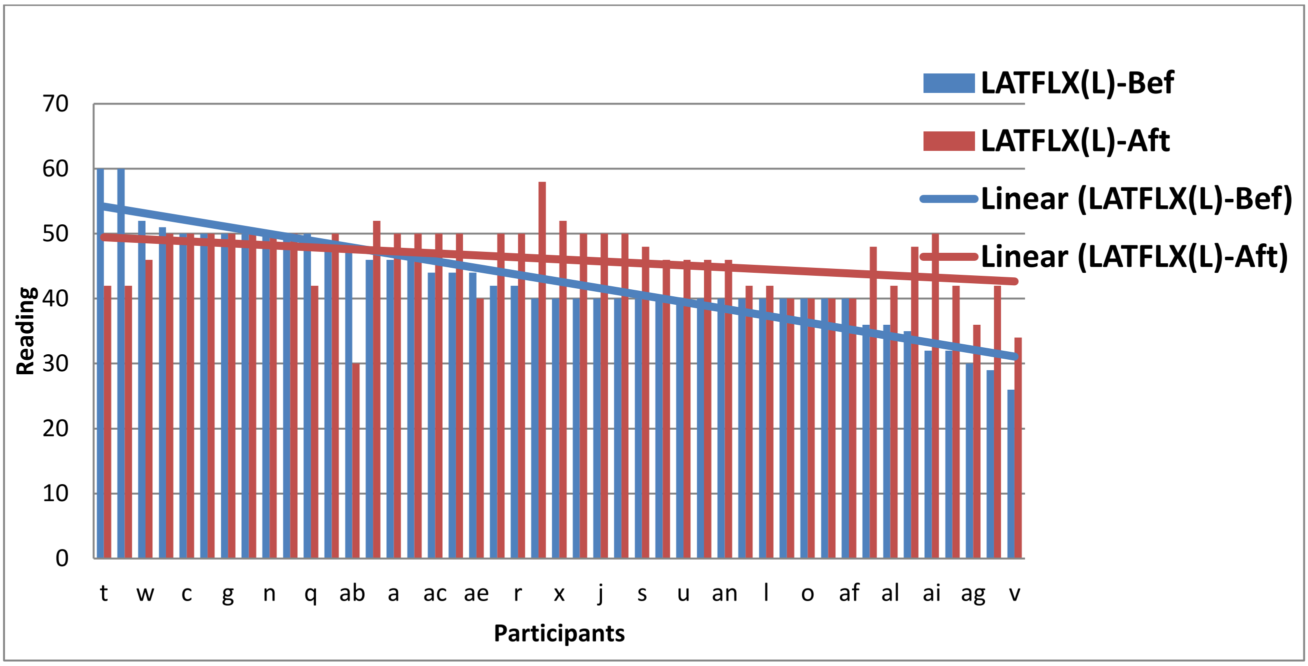


Figure 4.78 Pre/post overall results, lateral flexion left (*p*=0.014490265)

4.11.26 Cervical range of motion – Left Lateral Flexion – Gender

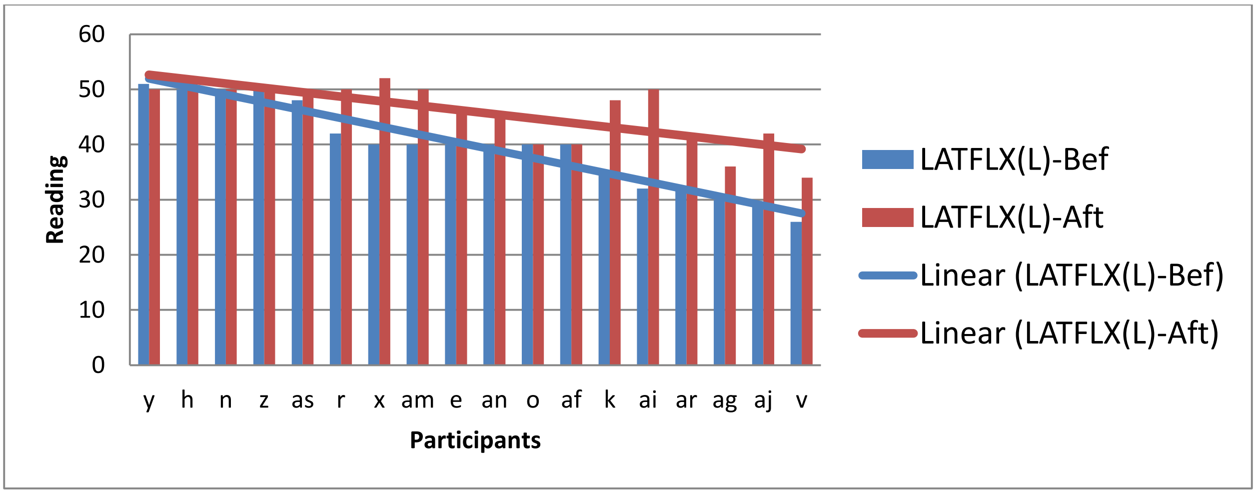


Figure 4.79 Pre/post results, range of motion, lateral flexion left, male only (n=18) (*p*=0.010766)

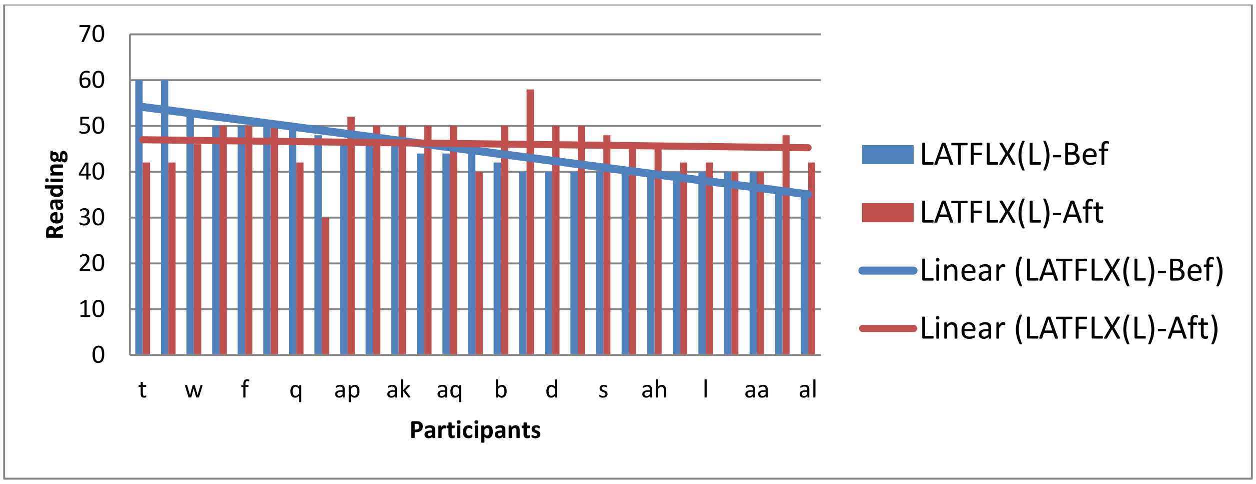


Figure 4.80 Pre/post results, range of motion, lateral flexion left, female only (n=27) (*p*=0.340903)

4.11.27 Cervical range of motion – Left Lateral Flexion – Ethnicity

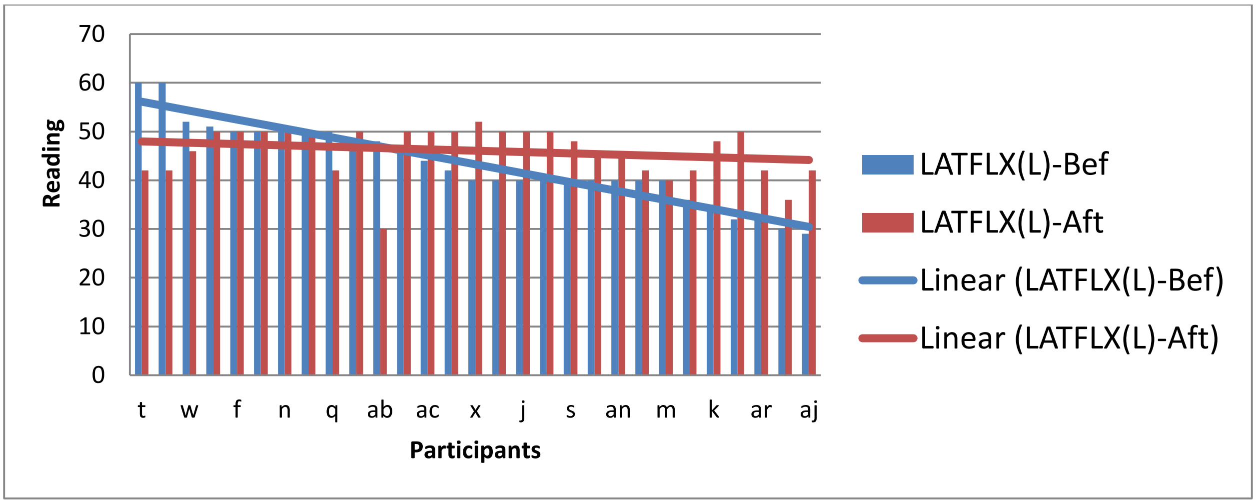


Figure 4.81 Pre/post results lateral flexion left, range of motion, White only (n=29) (*p*=0.123955)

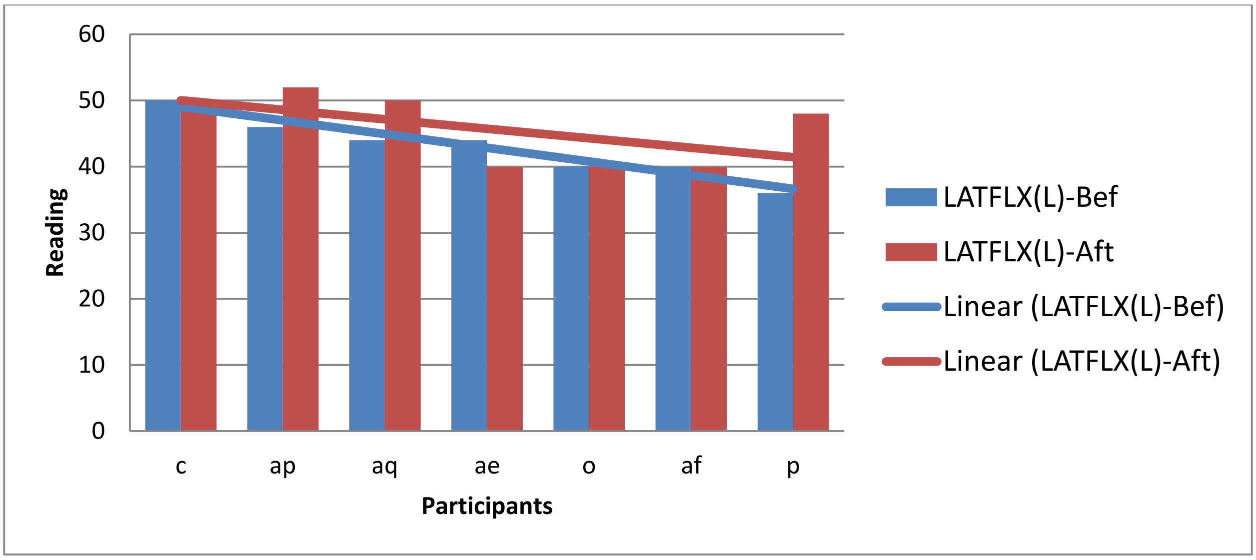


Figure 4.82 Pre/post results lateral flexion left, range of motion, Black only (n=7) (*p*=0.310881)

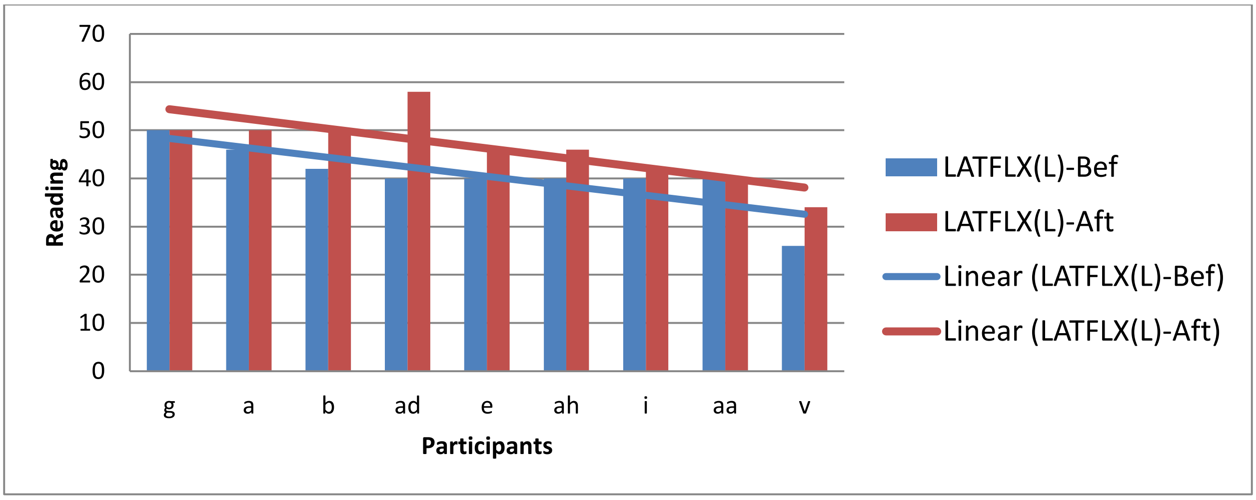


Figure 4.83 Pre/post results lateral flexion left, range of motion, Indian only (*p*=0.086753)

4.11.28 Cervical range of motion – Left Lateral Flexion – BMI

Left lateral flexion dependant on BMI was statistically analysed and the results were proven insignificant (*p*=<0.005), and therefore the graph has not been added into the chapter.

P values left lateral flexion including gender, and ethnicity (Table 4.8)

Overall *p*-value	**Sub-group**	**Number of participants (n=)**	***p*-value**
0.24985	M	18	0.1144
	F	27	0.8561
	W	29	0.5427
	B	7	0.3978
	I	9	0.4803

4.11.29 Range of motion summary:

Flexion showed a reduced range of motion at conclusion of the study (*p*=0.00864) which is considered a positive result and may be due to changes in muscle agonist and antagonist relationships as a result of normalized cervical biomechanics (Liebenson, 2007), This will be discussed further in Chapter Five.

Extension showed significant improvement at conclusion of the study (*p*=0.0000002).

Rotation left and right showed significant improvement at conclusion of the study (*p*=0.00003) and (*p*=0.00063) respectively.

Lateral flexion toward the right showed less improvement at conclusion of the study as compared to the left (*p*=0.24985) and was not statistically significant, however lateral flexion toward the left showed better results (*p*=0.0145) However, this was not statistically significant.

4.12 Neuromotor control of the cervical spine

Every segment of the spine has a particular neutral zone or a zone within which it is classified as being “optimal posture” (Gracovetsky, 1988). This optimal posture allows for optimal alignment of the ligaments (Holloway, 1994), muscles (Bloomfield, 1994; Zatsiosky, 1995) and joint surfaces. This allows for congruent and controlled movement (Brandt et al, 1986) as well as optimal weight bearing for the joints within the segments of the spine (Norkin and Levangie, 1992; Standring, 2008). In order to achieve this, certain factors need to be within a particular range and these having been reported to include:

- The CV angle. Ho Ting Yip (2007) suggests that 50º is an average angle needed for the CV angle in order to maintain normal or optimal head posture, therefore the greater the approximation to this degree would improve the posture of the head and neck and thus decrease symptoms in participants. Lau and lam et al, (2008) agree and suggest that the smaller the CV angle the greater the likelihood of FHP and therefore increased symptomatology.
- As a result of the CV angle, there is a direct impact on the range of motion (Foreman and Croft, 1995). With an increasing CV angle:
    - There is a decrease in flexion of the head and cervical spine (Lewit, 1991), as the range of motion of the cervical spine becomes less associated with protruding the jaw and translating one vertebra on another in the horizontal plane to achieve a “flexed position”. This is opposed to the optimal motion which is x-axis rotation for each vertebra around its own axis with limited protrusion of the jaw (Norkin and Levangie, 1992). This latter movement results in the participant being able to tuck their chin into their chest as opposed to moving the chin away from the chest to obtain the required movement.
    - There is an decreasing need for hyperextension of the head on the neck as well as the individual cervical vertebrae in order for the participant to be able to attain the required range of motion that activities of daily living would require of them, when in a non-optimal position (Lewit, 1991). With participants attuning optimal posture, there is an increase in the required extension ability of the participant as the vertebrae are required to rotate around their own x-axis.
    - With FHP, there is a limitation of rotation. This is thought to be related to the inability of vertebrae to rotate effectively around a neutrally placed y-axis, which allows for the vertebrae (Foreman and Croft, 1995) not only to carry the weight

of the head (Standring, 2008), but also avoid the close packed position of the joints of van Luschka (Standring, 2008) (which oppose some degree of rotation. Additionally the FHP shortens muscles (DCF) anterior to the vertebral body, decreasing their effect in facilitating the rotation movement (Hrysomallis and Goodman, 2001). Therefore optimal posture would restore normal range of motion with regards to rotation.

- There is usually limited impact on the lateral flexion as this occurs in the coronal plane as opposed to the sagittal plane (Moore and Dalley, 1999; Standring, 2008). This is related to the need for the participant to contract muscles unilaterally (Darby and Crammer, 1995). According to Bergmann and Peterson (2011) small changes should be anticipated due to the coupled movement patterns in the cervical spine, particularly with lateral flexion and rotation.

Summary of cervical ranges of motion and CV angles (Table 4.9)

Movement/measurement	**Normal ranges**	**Before intervention**	**After intervention**
Rotation	60º – 86º	67.2º / 68.6º	75º / 74.9º
Flexion	43º – 73º	50.8º	45.6º
Extension	33º – 77º	67.9º	76.5º
Lateral flexion	41º – 54º	44.1º / 42.6º	45.7º / 46º
Tamara and Zeevi (2008)			
CV angle (seat)	50º	39.5º	44.8º
CV angle (stand)		43.1º	48.8º
Ho Ting Yip (2007)			

Thus when assessing neuromotor control, it is essential from a proprioceptive vantage point that participants align with a posture as close to the optimal as possible (viz. XYZ axis neutral (Norkin and Levangie, 1992). Therefore in terms of participants in this study, this can be seen in that the following parameters approximated normal:

Based on the above results then, it is seen that the participants are better able to reflect the normal ranges of motion (with the ability to obtain ranges that are closer to the fullest range expected of them). This outcome means that the patients are more likely to be approximating the optimal posture for themselves. From this posture the neuromotor control becomes optimal (Totora and Derrickson, 2011; Crossman and Neary, 2005) as this is the functional reference point for all human movement as integrated by the cerebellum and the red nucleus (Crossman and Neary, 2005). Thus it can be concluded that the patients in this study were better able to attain movements previously unavailable and therefore improve their control. This is however a discussion that is limited by the lack of measures of such physiological parameters as proprioception. Therefore it is suggested that a future study incorporate not only range of motion and CV angle measures, but also measures of proprioception and neuro-vestibular function to confirm the suggestion as put forward in this study indicating, that improved range of motion is linked to an increase neuromotor control.

4.13 General considerations in terms of limitations of this study

The pool of participants consisted mainly of White males and females followed by Blacks and Indians, with no participants from the Coloured sample group. Additionally the gender split was uneven. This suggests an uneven or skewed sample pool making the results vulnerable to ethnic or gender variance including factors such as the cultural perspective of treatment, compliance with intervention, individual perspective of health, occupational limitations and participant expectations (Bergh and Theron, 1999).

From a statistical vantage point, statistically insignificant results (p=>0.005) and incomplete conclusions were drawn with regards to ethnicity and gender even though they were analysed separately to control for their influence on the overall results. As a result it is suggested that future research stratify the sample into gender and ethnic groupings to mitigate against the effect of these variables on the outcomes of the study.

Another limitation that needs to be considered is that this study ran over three to five weeks, where literature generally dictates that it would require a minimum four to six weeks for muscle to remodel with exercise related stress being placed on it (Jull and Sterling, 2008). These changes include the physiological changes that must occur to facilitate muscle improvement, such as muscular revascularisation, lipid and fibrous tissue breakdown. Additionally, where reduced movement was the consequence, improved neural regulation from the nervous system, and remodelling of the connective tissue involved such as muscle tendons and ligaments also needs to be considered (Tortora and Derrickson, 2006; Marieb, 2003; Robergs and Roberts, 1997).

A further consideration, that should be included in a future study, would be to look at the role of psychosocial stress, ergonomic and nutritional factors (Liebenson, 2007) on muscular aberrations with the DCF muscles; as these factors affect the more global muscles such as the sternocleidomastoid and anterior scalenes (Jull, 2000), which initiate the negative spiral of muscle changes and subsequent imbalances in the DCF musculature.

4.14 Overall comments / conclusion

The results attained in the study have provided significant outcomes in several measures and may be explained from a biomechanical point of view as notable improvement was achieved in range of motion in pre / post observation although this was most significant in rotation toward the left and right and in extension (p=<0.005), whilst lateral flexion toward the left improved significantly, but toward the right this improvement was less significant (p=>0.005). Flexion showed significant change, although this change was not aligned with the findings from other measures as it was due to a significant decrease in range of motion.

Exercise related soft tissue remodelling is known to have a significant effect on the cervical spine and hence the cervical biomechanics (Liebenson, 2007). According to Bogduk and Mercer, (2000), the most significant movements to occur at the C0-C1 vertebrae is flexion and extension (15 degrees) (Lewit and Krausova, 1963 cited in Bogduk and Mercer, 2000) (sagittal plane translation with x-axis rotation) with a small degree of rotation (y-axis rotation). This is consistent with the CCFE movement required in this study as the movement is specific to the upper cervical segments as discussed in Chapter Two. This is also consistent with the findings in this study which show most statistically significant overall changes noted (p=<0.005) in extension and flexion.

In a similar manner, but in the coronal plane and around the z-axis, lateral flexion requires the condyles to separate during this movement placing the joint capsule in a stressed position requiring support from the local musculature and connective tissue such as the sternocleidomastoid and inter-transverse ligaments (Moore and Dalley, 1999; Liebenson, 2007).

Related to the movements at the C0-C1 interface, this study focused principally on movement in the sagittal plane. In this context, the extensor musculature is generally tight and overused and combined with weak DCF musculature is responsible for the forward head posture noted in head and neck pain participants (Jull, 2002).

Although the participants in this study where asymptomatic they all show significant improvement in the CV angle suggesting this muscle pattern was notable. The reduction in flexion range of motion noted in this study was likely due to re-instated function of the DCF muscles with remodelling of the SCM muscle and anterior scalenes, this was so significantly notable in flexion range of motion because the study took place over a three to five week period as opposed to a three to six week period not allowing enough time for normal biomechanics to settle and for muscle remodelling to occur as suggested by Jull *et al* (2008). This also explains the reduction noted in lateral flexion as the SCM musculature would be forced to support lateral flexion, rendering it transiently hypertonic during this phase of connective tissue remodelling (Robergs and Roberts, 1997). This as a result took of CCFE exercise protocol

This is consistent with the findings in this study as although these participants were asymptomatic with regard to pain, they all did show significant improvement in the CV angle, seated and standing measurements (p=<0.005) suggesting muscular remodelling and changes in biomechanics.

Lateral flexion toward the right has shown the least significant results, this was also demonstrated in the results in right rotation but to a lesser degree. In a study conducted by (Shih and Kao, 2011) (p=0.001) hand dominance had a significant effect on the cervico-scapular biomechanics by resulting in a posterior tilting of the scapular. This, as described in Chapter Two demonstrates the effect of over use on the levator scapular muscle an posterior extensors and shows that asymmetrical muscle shortening and hence altered biomechanics of the cervical spine is a likely reason for these results. The majority (n=43) of the 45 participants in this study were right handed, and therefore, further justifies these findings.

Chapter Five
Conclusion

5.1 Conclusion

The study was motivated due to the paucity in the literature regarding the craniocervical flexion exercise (CCFE) in an asymptomatic group of people. Although there is a clear link between postural abnormalities such as forward head posture and its sequelae of neck and head pain, more research is required in order to determine the role of CCFEs in the amelioration, treatment and prevention of these sequelae.

In addition, CCFE may be used as a prophylactic or treatment exercise protocol in patients who are otherwise contra-indicated to manipulation, such as those with a history of cervical instability or vertebral artery insufficiency.

Thus, this research aimed to offer practitioners, such as chiropractors a tool other than manipulation, in the prophylactic management of head and neck pain of mechanical origin.

The results of this study indicate that:

- CCFE in the asymptomatic population does have a significant (p=<0.005) impact on active range of motion in the cervical spine.
- CCFE in the asymptomatic population does have a significant (p=<0.005) impact on head posture as described by the CV angle.
- The results from this research indicate that an ideal posture may be possible to establish in the asymptomatic group, although this ideal posture is specific to the individual (as this was a pre-post intervention study by design).

Thus, CCFE may be used as a prophylactic tool in the prevention of mechanical neck and head pain in patients with poor cervical posture (as defined by a decreased CV angle and abnormal range of motion patterns).

5.2 Recommendations

Methodological recommendations:

1. To ensure more accurate data, ethnic sub-groups should be divided into equally numbered groups (viz. the research groups should have ethnic stratification). This will ensure more accurate results.
2. To ensure gender specific results are made more accurate, these groups, Male and Female should be divided into two equal groups improving data accuracy (viz. the research groups should have gender stratification).
3. The sample size used was one group of forty-five participants. Perhaps a larger sample size would have given more significant results or allowed for appropriate stratification methods to be employed.
4. Having a control group (natural history group), a placebo group or a combination of these alongside an intervention group would have better allowed for the contextualisation of the results with reference to a patient norm reference.
5. Further research needs to be done to determine a standardised and normalized range for the CV angle, so as to better enable a set reference point for clinical practice and research.

5.3 Practical / clinical recommendations

6. Practitioners should consider including CCFEs as they are low cost, but highly effective in the treatment of patients with mechanical disorders of the cervical spine. This may be either as a single intervention or as a combination of interventions.
7. Patients at risk for injury or who are contra-indicated for care should perhaps consider the use of CCFEs as they would enable limited motion / minimal motion in order to restore normal posture and mechanics as compared to a manipulation and other forms of muscle work (e.g. PNF stretching). This would similarly apply to vulnerable groups such as the elderly.

5.4 Further research studies that could be considered

Further research needs to be done with regard to ethnic variations in the craniovertebral angle as well as variations with age in the craniovertebral angle. This may help to establish baseline readings for normal craniovertebral angles and will assist in the diagnosis and treatment, be it prophylactic or symptomatic of patients.

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Appendices

Appendix A: Advertisement

Appendix B: Letter of information

Appendix C: Case history

Appendix D: Senior physical exam

Appendix E: Cervical spine regional exam

Appendix F: SOAPE note

Appendix G: Ethics clearance certificate

Appendix H: Research budget

Appendix A: Advertisement

Are you between the ages of **18** and **45**?

Research is currently being carried out at the Durban University of Technology Chiropractic Day Clinic

Would you like to make your neck muscles stronger?

Would you like to reduce your risk of developing arthritis of the neck, neck pain and headache?

If you have no recent history of neck pain, jaw pain or headache and have not had any surgical procedures to the neck you may qualify to take part free of charge.

Free Treatment

Available to those who qualify to take part in this study

Contact **AARYN CAMITSIS** on 0846009945 or

031 373 2205 / 2512 for more information.

Appendix B : Letter of Information and Informed Consent Form

Dear Participant

Thank you for joining my research. I am a chiropractic student completing my (M.Tech) Chiropractic degree. Outlined below is a brief description of the study and what will be needed from you. Your participation is greatly appreciated and your involvement is contributing to making a successful study.

Title of the research study: The effect of craniocervical flexion exercise on cervical posture and cervical range of motion in asymptomatic patients.

Principle researcher:

Aaryn Camitsis Contact number 0313732205 / 0846009945

Research supervisor:

Dr Grant Matkovich [M.Tech-Chiropractic] Contact number 0312018204

Health research ethics administrator: Contact number 0313732900

Brief Introduction and Purpose of the Study:

You have been selected to be part of the research programme. This research programme will determine the effectiveness of Craniocervical flexion exercises aimed specifically at the neck to measure its effect on neck range of motion and neck posture in asymptomatic participants. You will be allocated to one group. Each individual will receive a clinical treatment.

Outline of the procedures:

At the initial appointment you will be given this letter of informed consent to read and understand. Once you agree to participate and sign the informed consent letter, you will be screened to determine whether you are suitable for this study. I will use a case history, physical examination and neck (cervical spine) examination as per DUT chiropractic clinic protocol to ensure patient safety. If you meet the requirements, you will be required to attend five consultations covering a maximum period of five weeks at the Durban University of Technology Chiropractic Day Clinic. The first and fifth consultations may take a maximum of one hour with the second, third and fourth consultations taking a maximum of forty minutes. During the course of the study, you are requested to not change your daily activities/lifestyle, if you do, please report this to the researcher as this may interfere with the outcomes of the study.
A home exercise protocol will be required of the participant for the duration of the study that will be explained by the researcher. An exercise diary will be given to each participant to monitor the home exercise requirements.
The study is limited by participant compliance with this home protocol. Failure to comply with this protocol may result in sub-optimal results.

If you do not agree to participate in this study, the research appointment will be terminated and you will be given an option to make an appointment with another available student as a non-research patient at the Chiropractic Day Clinic.

Risks or discomforts to the subject:

You will receive treatment that is safe and hypothesised to benefit you, whilst I am working under the supervision of a qualified Chiropractor.
Mild post muscle soreness may develop after exercise. Post muscle soreness is mild discomfort as a result of activity, similar to stiffness and is transient in nature; therefore if you experience this there will be no long term consequences. Post muscle soreness is a normal reaction to exercise in general (Sayers 2007). In the event of these above mentioned outcomes, you are free to withdraw from the research process at any time and will still receive one free treatment at the DUT Chiropractic clinic.

Benefits:

Improvement in neck posture and general neck range of motion.

Reason/s why you may be withdrawn from the study

If you experience any adverse reactions as a result of treatment received with the required research process. If you have unexpected adverse reactions to the treatment, If you are unwilling to continue and / or require further care that is outside of the scope of this study.

Remuneration/ Costs of the study:

You will not receive any form of remuneration for taking part in the study; neither will you be charged for the treatments involved in the study. If however you would like further treatment upon completion of the study, normal consultation rates will apply as is applicable to all Chiropractic Day Clinic outpatients.

Confidentiality:

All patient information relevant to the study will be kept confidential and will be stored in your file at the Chiropractic Day Clinic for five years, after which it will be disposed of (shredded). The results of the study will be made available at the Durban University of Technology Library for educational purposes, but no patient information will be revealed.

Persons to contact in the event of any problems or queries:

If you have any questions or problems with respect to the study please feel free to contact my research supervisor, Dr. Grant Matkovich on 031201820 or you can contact the Faculty of Health Sciences research administrator on, 0313732900.

Statement of agreement to participate in the research study:

I,….................................... (subject's full name), ID number…….................................., have read this document in its entirety and understand its contents. Where I have had any questions or queries, these have been explained to me by Aaryn Camitsis to my satisfaction. Furthermore, I fully understand that I may withdraw from this study at any stage without any adverse consequences and my future health care will not be compromised. I, therefore, voluntarily agree to participate in this study.

Subject's name (print) ………………………………………………………………………………..…

Subject's signature:………………..………………………………………..…….. Date:……………..…

Researcher’s name (print) signature: …………………………………………………………………...

Researcher’s signature:……… …………………………………………………..Date:........................

Witness name (print) signature: ……………………………………………………………….………...

Witness signature: …………...……………………………………….................Date:…….…………

Appendix C : Case History

DURBAN UNIVERSITY OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
CASE HISTORY

Patient: ______________________________ Date: __________

File # : Age: __________ __________

Intern: ______________________ Signature ______________________

FOR CLINICIANS USE ONLY:

Initial visit

Clinician: Signature:

Case History:

Examination:

Previous: Current:

X-Ray Studies:

Previous: Current:

Clinical Path.lab:

Previous: Current:

CASE STATUS:

PTT:	Signature:	Date:

CONDITIONAL:

Reason for Conditional:

Signature: Date:

Conditions met in Visit No:	Signed into PTT:	Date:
Case Summary signed off:		Date:

Intern's Case History:

1. **Source of History:**

2. **Chief Complaint: (patient's own words):**

3. Present Illness:

	Complaint 1	Complaint 2
Location Onset : Initial: Recent: Cause: Duration Frequency Pain (Character) Progression Aggravating Factors Relieving Factors Associated S and S Previous Occurrences Past Treatment Outcome:		

4. Other Complaints:

5. Past Medical History:

- ☐ General Health Status
- ☐ Childhood Illnesses
- ☐ Adult Illnesses
- ☐ Psychiatric Illnesses
- ☐ Accidents/Injuries
- ☐ Surgery
- ☐ Hospitalizations

6. Current health status and life-style:

- ☐ Allergies
- ☐ Immunizations
- ☐ Screening Tests incl. x-rays
- ☐ Environmental Hazards (Home, School, Work)
- ☐ Exercise and Leisure
- ☐ Sleep Patterns
- ☐ Diet

- Current Medication
  Analgesics/week:
- Tobacco
- Alcohol
- Social Drugs

7. Immediate Family Medical History:

- Age
- Health
- Cause of Death
- DM
- Heart Disease
- TB
- Stroke
- Kidney Disease
- CA
- Arthritis
- Anaemia
- Headaches
- Thyroid Disease
- Epilepsy
- Mental Illness
- Alcoholism
- Drug Addiction
- Other

8. Psychosocial history:

- Home Situation and daily life
- Important experiences
- Religious Beliefs

9. Review of Systems:

- ☐ General
- ☐ Skin
- ☐ Head
- ☐ Eyes
- ☐ Ears
- ☐ Nose/Sinuses
- ☐ Mouth/Throat
- ☐ Neck
- ☐ Breasts
- ☐ Respiratory
- ☐ Cardiac
- ☐ Gastro-intestinal
- ☐ Urinary
- ☐ Genital
- ☐ Vascular
- ☐ Musculoskeletal
- ☐ Neurologic
- ☐ Haematologic
- ☐ Endocrine
- ☐ Psychiatric

APPENDIX D: PHYSICAL EXAMINATION

Durban University of Technology
PHYSICAL EXAMINATION: SENIOR

Patient Name : File no : Date :
Student : Signature :

VITALS:					
Pulse rate:			Respiratory rate:		
Blood pressure:	R	L	Medication if hypertensive:		
Temperature:			Height:		
Weight:	Any recent change? Y / N		If Yes: How much gain/loss	Over what period	

GENERAL EXAMINATION:		
General Impression		
Skin		
Jaundice		
Pallor		
Clubbing		
Cyanosis (Central/Peripheral)		
Oedema		
Lymph nodes	Head and neck	
	Axillary	
	Epitrochlear	
	Inguinal	
Pulses		
Urinalysis		

SYSTEM SPECIFIC EXAMINATION:

CARDIOVASCULAR EXAMINATION

RESPIRATORY EXAMINATION

NAL EXAMINATION

.OGICAL EXAMINATION

COMMENTS

Clinician: Signature :

Appendix E: Cervical regional exam

DURBAN UNIVERSITY OF TECHNOLOGY
REGIONAL EXAMINATION - CERVICAL SPINE

Patient: .... File No: ....

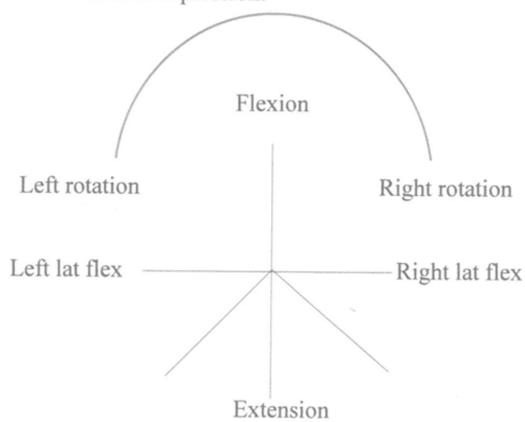
Date: .... Student: ....

Clinician: .... Sign: ....

OBSERVATION:
Posture
Swellings
Scars, discolouration
Hair line
Body and soft tissue contours

Shoulder position
Left :
Right :
Shoulder dominance (hand):
Facial expression:

RANGE OF MOTION:
Extension (70°):
L/R Rotation (70°):
L/R Lat flex (45°):
Flexion (45°):



PALPATION:
Lymph nodes
Thyroid Gland
Trachea

ORTHOPAEDIC EXAMINATION:

Tenderness		Right	Left
Trigger Points:	SCM		
	Scalenii		
	Post Cervicals		
	Trapezius		
	Lev scapular		

	Right	Left		Right	Left
Doorbell sign			Cervical compression		
Kemp's test			Lateral compression		
Cervical distraction			Adson's test		
Halstead's test			Costoclavicular test		
Hyper-abduction test			Eden's test		
Shoulder abduction test			Shoulder compression test		
Dizziness rotation test			Lhermitte's sign		
Brachial plexus test					

NEUROLOGICAL EXAMINATION:

Dermatomes	**Left**	**Right**	**Myotomes**	**Left**	**Right**	**Reflexes**	**Left**	**Right**
C2			C1			C5		
C3			C2			C6		
C4			C3			C7		
C5			C4					
C6			C5					
C7			C6					
C8			C7					
T1			C8					
			T1					

Cerebellar tests:	Left	Right
Disdiadochokinesis		

VASCULAR:	**Left**	**Right**		**Left**	**Right**
Blood pressure			Subclavian arts.		
Carotid arts.			Wallenberg's test		

MOTION PALPATION & JOINT PLAY:
Left: Motion Palpation:
Joint Play:
Right: Motion Palpation:
Joint Play:

BASIC EXAM: SHOULDER:

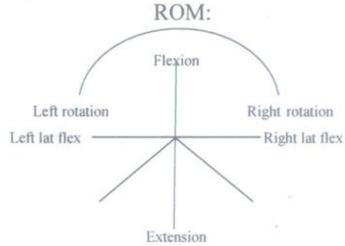
Case History:

ROM: Active:
Passive:
RIM:
Orthopaedic:
Neuro:
Vascular:

BASIC EXAM: THORACIC SPINE:

Case History:

ROM:



Motion Palpation:	
Orthopaedic:	
Neuro:	
Vascular:	
Observ/Palpation:	
Joint Play:	

Faculty of Health Sciences

DURBAN UNIVERSITY of TECHNOLOGY

ETHICS CLEARANCE CERTIFICATE

Student Name	Aaryn Leonidas Camitsis	**Student No**	20430985
Ethics Reference	**IREC 006/12**	**Date of FRC Approval**	12/06/2012
Qualification	**M.Tech: Chiropractic**		
Research Title:	**The effect of cranio-cervical flexion exercise on cervical posture and cervical range of motion in asymptomatic patients.**		

In terms of the ethical considerations for the conduct of research in the Faculty of Health Sciences, Durban University of Technology, this proposal meets with Institutional requirements and confirms the following ethical obligations:

1. The researcher has read and understood the research ethics policy and procedures as endorsed by the Durban University of Technology, has sufficiently answered all questions pertaining to ethics in the DUT 186 and agrees to comply with them.
2. The researcher will report any serious adverse events pertaining to the research to the Faculty of Health Sciences Research Ethics Committee.
3. The researcher will submit any major additions or changes to the research proposal after approval has been granted to the Faculty of Health Sciences Research Committee for consideration.
4. The researcher, with the supervisor and co-researchers will take full responsibility in ensuring that the protocol is adhered to.
5. ***The following section must be completed if the research involves human participants:***

	YES	NO	N/A
❖ Provision has been made to obtain informed consent of the participants	X		
❖ Potential psychological and physical risks have been considered and minimised	X		
❖ Provision has been made to avoid undue intrusion with regard to participants and community	X		
❖ Rights of participants will be safe-guarded in relation to: - Measures for the protection of anonymity and the maintenance of Confidentiality.	X		
- Access to research information and findings.	X		
- Termination of involvement without compromise	X		
- Misleading promises regarding benefits of the research	X		

SIGNATURE OF STUDENT/RESEARCHER DATE

SIGNATURE OF SUPERVISOR/S DATE

SIGNATURE OF HEAD OF DEPARTMENT DATE

SIGNATURE: CHAIRPERSON OF RESEARCH ETHICS COMMITTEE DATE

Appendix H- Research budget

Section A: Budget		**(Motivate below – see PG Guidelines)**	
1.	**Consumable Details** (Motivate)	@ R0,28page single side @ R0.40 page double sided • 55 x Informed consent /Letter of Information = 55 d/s • 55 x Case History = 110 d/s • 55 x Physical Exam = 165 d/s • 55 x Cervical Regional Exam = 55 d/s • 55 x SOAPE note = 55 d/s • 55 x Data collection sheets (algometer and CROM) • 55 x exercise diary = 55 d/s	**R198-00**
3.	**Books/Journal/Documents**		**R600-00**
4.	**Outside services**	Statistical analysis	**R3200-00**
		Proof reading	**R1000-00**
5.	**Equipment**	CCFT pressure cuff Smart tool angle finder	**R850-00** **R 3000-00**
7.	**Other**	• Telephone calls/faxing x 55 patients x 5 phone calls @ R2 a call • Advertising	**R550-00** **R600-00**
	TOTAL		**R9998-00**