PSi SEATING LIMITED

AN INDEPENDENT REPORT

January, 2018

REMIT OF THIS REPORT

This final independent report recognises the agreement established in the contract between PSi Seating Ltd and the University of Central Lancashire (Allied Health Research Unit). This report discusses all the main outcome measures of this study including all data and meets the full contractual obligation between the parties.

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EXPLORING THE EFFECT OF SEAT DESIGN ELEMENTS THROUGH BIOMECHANICAL FACTORS

Project Summary

This study explores the biomechanical effects of the Apex Chair against a "Standard" office chair. 15 Healthy individuals aged 18-60 were recruited to the study. Spinal alignment and peak pressure data was collected during a standardised typing task with both chairs, using a four segment spinal model. The Apex Chair was tested both at a 0 degree tilt angle and a 8 degree tilt angle. Subjective feedback was obtained. Results are summarised below.

- **BASELINE:** At baseline, over 64% of individuals experienced occasional discomfort, with 50% requiring frequent repositioning in their seat. Fifty percent of individuals suggested that the most support their current chair gave was in the hip and lower back area.
- **PEAK PRESSURES:** Results showed that the lowest peak pressures were recorded for the Apex Chair at 0° (8.21KPa) whereas the highest was recorded for the Apex chair at 8° (10.78). Therefore results showed that using a pelvic tilting chair may increase seated peak pressures. For both the Apex conditions, peak seating pressures increased significantly over the trial period. Whilst the pressure for the Apex Chair at 0° was still lower than the standard chair, it is notable that the standard chair compacted and settled quicker than the Apex chair.
- **SPINAL ALIGNMENT:** Spinal posture in the lumbar region coronal plane (side to side movement, was bought closest to neutral posture when sitting on the Apex tilted chair (8°) showing that this posture has a distinct benefit.
- **COMFORT:** The Apex Chair at 0° (no tilt) was found to be significantly more comfortable of the 3 conditions tested followed by the Apex 8° (tilted chair) then the Standard chair.
- **FIRMNESS/SUPPORT:** Though this wasn't statistically significant, individuals found the Apex 0° (no tilt) the most firm/supportive and the standard chair the softest and least supportive of the three.
- **PREFERENCE:** Sixty percent of individuals preferred the Apex 8° tilted chair whilst the remainder 40% preferred the Apex 0° (no tilt). 73% of individuals placed the standard chair as their least preferred chair of the three tested conditions.

All variables were scored and ranked to give each chair a total score on performance, rating the Apex 0° tilt as the best performing and most preferred chair of the 3 options, closely followed by the Apex 8° (tilted) chair.

1.0 INTRODUCTION

Office workers often assume a slumped or relaxed sitting posture while working at a desk for a prolonged period (Watanbe et al, 2007). Fatigue of the lumbar extensor muscles while sitting for long hours makes it difficult to maintain an erect posture with the normal lordotic curve and increased anterior pelvic tilt (Neumann, 2002). Development of this habitual, slouched posture can lead to further thoracic problems and lead to or be brought on by, the forward rounded shoulder posture (FRSP) (Han, Lee & Yoon, 2015). FRSP can result from habitual and excessive trunk flexion and is characterised by a protracted, downwardly rotated, and anteriorly tipped scapula position with increased cervical lordosis and upper thoracic kyphosis (Wong et al, 2010). In addition, rounded shoulder posture can occur in athletes which typically perform overhead activities such as throwing, hitting or striking motions (Cole et al, 2013), which can then lead to shoulder pain and pathological conditions from tissue overuse. Therefore, effective protocols to correct this postural abnormality is needed in a variety of different populations.

With over 40% of all employees in the EU working at a computer (Ellegast, et al., 2012), it is common in the western civilisation for office workers to sit at their desk for long periods of time (Mörl & Bradl, 2013). In fact, the sitting position is currently the most common posture in the workplace (Lee & Yoo, 2011).

It has been widely accepted that prolonged seated work results in increased discomfort over time, more specifically it has been associated as a risk factor to lower back pain (Tanoue, et al., 2016, Callaghan, et al., 2010, Karakolis & Callaghan, 2014) and can aggrevate neck pain (Lee & Yoo, 2011). Therefore the design of office chairs is becoming progressively more important in order to prevent musculoskeletal disorders within office workplaces (Ellegast, et al., 2012).

1.1 POSTURE

The forward head posture (FHP) is a posture typically adopted in the workplace; it combines lower cervical flexion, upper cervical extension (head tilt) and scapular protraction and elevation (rounded shoulders) (Szeto, et al., 2002, Lee & Yoo, 2011). Moreover, following common clinical observations individuals suffering from neck and shoulder pain often demonstrate the FHP position (Szeto, et al., 2002). Although it is difficult to pin-point the exact cause-and-effect relationship of pain and posture, previous studies have proposed that continuous flexion of the cervical spine consequently causes an increased compressive loading in the cervical spine; with the tissues producing a creep response (Szeto, et al., 2002). Therefore it is important to teach office workers to maintain the correct posture, where the lumbar spine has a degree of extension (lordosis) opposed to lumbar spine kyphotic (slumped) (Lee & Yoo, 2011).

With this being said, it can be challenging to maintain ideal posture with the natural lordosis and increased anterior pelvic tilt whilst sitting for a long period of time as the lumbar extensor muscles fatigue increases with persistent sitting (Lee & Yoo, 2011). Consequently, many develop a slumped position during the prolonged sitting endured in office work. However, a previous study found no significant evidence for change in posture over time throughout a day of prolonged sitting, although it was recorded that the seated posture alone caused a 10% increase in forward head posture in comparison to standing (Lee & Yoo, 2011).

1.2 Pressure

Carcone & Keir (2007) studied the effects of lumbar support on biomechanical variables and comfort whilst sitting during office work. The study reported that the addition of a supplementary backrest siginifcantly reduced average backrest pressure, along with mean peak backrest pressure, and mean contact area (Carcone & Keir, 2007). Although pressure distribution seems to be associated with comfort in car seats, there has been little evidence in office applications, and with the relationship between posture and muscle activity and comfort also being unclear (Carcone & Keir, 2007).

1.3 Pelvic Inclination

Annetts et al. (2012) studied the angles of inclination for the posterior pelvic, neck and head, along with lumbar lordosis of the subjects when sitting on four different chairs. It was concluded that when comparing dynamic and static chairs, no chair consistently provided an ideal posture for every region so it was recommended that chairs should be selected based on the individual's needs (Annetts, et al., 2012). This study also observed the region association between the neck angle/head tilt and the posterior pelvic tilt/lumbar lordosis, with an ideal lumbopelvic position not necessarily resulting in an ideal cervical position simultaneously (Annetts, et al., 2012).

Tilt-in-space (TIS) wheelchairs or seats have been frequently used for individuals who cannot walk, typically with neurological or neuromuscular impairments (Michael, et al., 2008) to address the issue of pressure redistribution required in prolonged sitting (Giesbrecht, et al., 2011). The TIS wheelchairs incorporate the rotation of the entire seating system backwards within the wheelchair frame whilst keeping a fixed seat-to-backrest angle (Giesbrecht, et al., 2011). This function allows the individuals orientation relative to gravity to be altered, so the typical force between the seat and buttocks can be reduced (Giesbrecht, et al., 2011). Disadvantages to the TIS wheelchairs consist of the additional cost, size and weight in comparison to a normal wheelchair along with an extreme tilt backwards causing a limit to communication, upper limb function and accessibility (Michael, et al., 2008).

A backwards-tilted seated position has been proposed to improve head and trunk posture and reduce the load under the buttocks and spine. A forwards-tilted seated position has been suggested to maintain lumbar lordosis, reduce the posterior pelvic tilt, lessen the effect of tight hamstrings on the pelvis position and ultimately reduce pressures at the interface beneath the pelvis (Michael, et al., 2008). Similar to previous findings, the results from this study suggested a tilt angle of 30° at least is required to produce a clinically valuable reduction in pressure but small tilt angles can support posture and positioning (Michael, et al., 2008). However more research in this field is required as there is currently a lack of in depth evidence-based research published on the effects of a tilted seat positions (Michael, et al., 2008).

1.4 Current Interventions

It has been advised that incorporating movement/posture adjustment into prolonged sitting is a method for reducing physical stress (Tanoue, et al., 2016). More specifically, Tanoue, et al (2016) reported that altering the positions of the lumbar vertebrae and pelvis during sitting reduces posture-related pain. Posture adjustment can range from simply shifting seating position to changing to a standing position or even more extreme interventions such as treadmill walking (Karakolis & Callaghan, 2014).

The introduction of sit-stand workstations have been increasingly implemented into office workplaces (Karakolis & Callaghan, 2014). A small survey studied the effectiveness of sit-stand stations; it was stated that only a small percentage (one in ten office workers) used the available sit-stand feature on their workstation on a daily basis (Karakolis & Callaghan, 2014). The reasoning behind this low utilisation appeared to be the significant influence of motivation, those with physical problems/pain were more likely to use the sit-stand feature than those who just obtained the feature through the refurbishment within their workplace (Wilks, et al., 2006). Similarly lower utilisation rates were evident in older generation workers

(Wilks, et al., 2006). Additionally, Davis et al (2009) reported that software reminders for posture adjustment were more effective in terms of reducing discomfort and retaining productivity in comparison to sit-stand workstations. Therefore, an adaptation to conventional static/dynamic office chairs would be beneficial as the sit-stand workstations are not suitable for all workers.

Office chairs produced by European manufacturers generally comply with standard criteria documented in the European EN-1335 and the Dutch NPR-1813 standards, which are based upon anthropometrics and safety standards (Groenesteijn, et al., 2009). Anthropometry is important in order to avoid discomfort for the general population and to offer optimal physical support for a wide range of end-users (Vink, 2005, Groenesteijn, et al., 2009).

1.5 Aims

This study aims to look at the biomechanical effects of the apex chair that aims to be fully adjustable (including seat incline) to offer a bespoke fit compared to a standard office chair.

2.0 Method

2.1 Participant recruitment

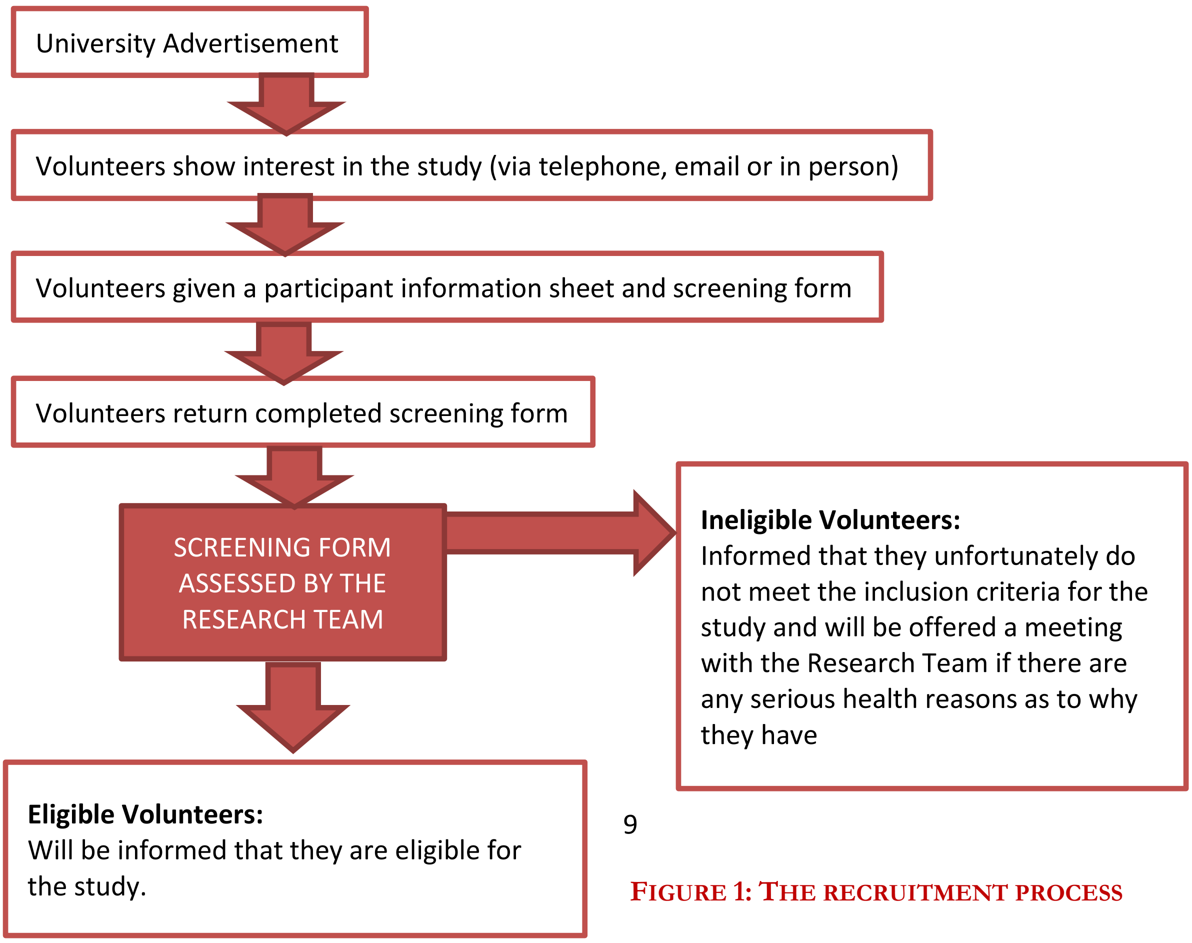

Figure 1: The recruitment process

Participants were recruited (Figure 1) from within the University including UCLan staff and students through campus based advertisements and social media. Volunteers from outside the University who heard of the study through word of mouth (due the study's snowballing effects) were also included. Participants were required to actively volunteer for the study by contacting the researchers if they were interested in participating in the study using the contact information on the advertisements. Once a volunteer had shown interest in the study, they were given an information sheet to read and keep and a screening form (Greenhalgh & Selfe, 2010) to fill and securely return. Participants were provided with the opportunity to ask the research team any questions regarding the study. All participants were required to meet the inclusion criteria stipulated; to be free from any spinal red flags, free from spinal pain, with no history of any back surgery, not currently pregnant with comfortable mobility in the spine.

2.2 PROCEDURE

Fifteen healthy participants aged between 18 and 60 years old, with no history of back pain or back/clavicle injury in the last 6 months were recruited for the study. The participants visited the Movement Laboratory at the University of Central Lancashire for a single one-hour session. Data was collected on spinal alignment and during a typing task both with and without the intervention.

The participants were required to wear appropriate garments that may be lowered to the hips (eg. Skirt, trousers, tracksuit bottoms, leggings) and were provided with an open back t-shirt to allow easy access to the back. The spinous processes of the spine were palpated in order to locate the points for markers to be placed upon. All tasks and conditions were randomised for each participant (www.randomisation.com).

2.3 BASELINE DATA

Participants were asked to complete a consent form in line with the ethical guidance, before being asked some baseline questions including demographic data (age, gender, height, weight), questions related to the comfort and effectiveness of each chair setup were completed after each intervention. The participant was asked which intervention was the preferred method of support and why. The three interventions tested were: 1) Standard office chair; 2) Apex Chair 0° tilt 3) Apex chair with an 8° pelvic tilt.

FIGURE 2 - APEX POSTURE SEAT WITH BACK REST REMOVED

FIGURE 3 - STANDARD OPERATOR CHAIR WITH BACK REST REMOVED

2.4 BIOMECHANICAL DATA

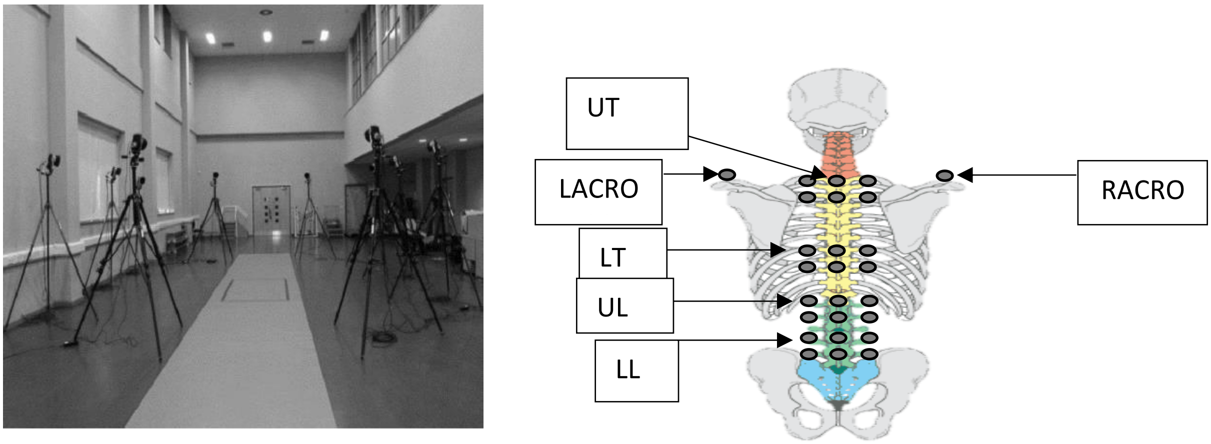

FIGURE 4: THE MOVEMENT ANALYSIS LABORATORY (LEFT) THE RETROREFLECTIVE MARKER SETUP (RIGHT)

Small retroreflective tracking markers were attached to each individual using a 4 segment spinal model and the Calibrated Anatomical System Technique (Capozzo, 1995) for the pelvis. Data from the retroreflective markers was recorded using a 10-camera Oqus Qualisys motion capture system (Qualisys AB, Sweden). Movement data was collected using Qualisys Track Manager (QTM v.2.13; Qualisys AB, Sweden) and analysed using Visual 3D (C-Motion, MD, USA). Figure 4 illustrates the marker set up used. Before the participant are tested in either condition, a calibration static file was obtained of the participant's normal standing posture. The first cluster set was located with the top central marker being placed on C7 allowing the tracking of the upper thoracic (UT). The top central marker of the second cluster was placed on the spinous process in line with the bottom edge of the scapula (around T8) allowing the tracking of the lower thoracic (LT). The top central markers of the third cluster was placed on L1 spinous process, allowing the tracking of the upper lumbar (UL). The top middle marker of the fourth cluster was placed on L5 allowing the tracking of the lower thoracic (LL). Markers were also placed on the left and right acromion and sternal notch to allow for the tracking of the shoulder (L/RACRO) as well as on the superior end of the sternum, the ASIS of the pelvis and the calcaneus (L/RCALC).

2.5 TASKS

The typing task consisted of the participants completing a standardised typing task whilst sitting on three different office chair interventions, with the back support removed in order to prevent the markers being obscured. The seat height was adjusted to ensure that a 90° sagittal plane knee angles at the start of each trial (Figure 5). The trial lasted 10 minutes and data was collected for a period of 30 seconds at the following time points- 0, 2.5, 5, 7.5 and at 10 minutes. This was blinded from the participants so they were unaware of when data collection is taking place to prevent any conscious changes in posture during recordings. This was repeated three times, once for each intervention. The camera system and layout of the laboratory is shown in figure 4. The participant was recorded using the Qualisys 3D camera system. The participants were then asked for their views on aspects of the interventions.

FIGURE 5: ILLUSTRATION OF SEATED POSITION FOR TYPING

2.6 PROTOCOL SUMMARY

PRE-ASSESSMENT:
Volunteer asked to read participant information sheet and complete screening form

ARRIVAL TO MOVEMENT LABORATORY:
- ✓ Participant Consent taken
- ✓ Participant completes pre-testing questionnaire
- ✓ Participant's anthropometric measurements are taken by researcher.
- ✓ Participant is fitted with markers and assigned a randomized order (Chair, Apex no tilt, Apex 8° tilt).

DATA COLLECTION – 1st Intervention:
- ✓ Participant completes first task
- ✓ Participant completes questionnaire

DATA COLLECTION – 2nd Intervention:
- ✓ Participant completes first task
- ✓ Participant completes questionnaire

DATA COLLECTION – 3rd Intervention:
- ✓ Participant completes first task
- ✓ Participant completes questionnaire 2 part 1

FIGURE 6: A SUMMARY OF THE PROTOCOL STAGES

3.0 RESULTS

This study has seen that 18 individuals have contacted the research team for information about the study, three were excluded immediately as they did not meet the inclusion criteria for the study. Of the remaining participants 15 completed the screening form (100%) to assess eligibility and have been included. All data collection conformed to the declaration of Helsinki and volunteers gave written informed consent prior to participation. The study was approved by the University's ethics committee (STEMH #666).

3.1 BASELINE MEASUREMENTS

A total of (n=15) participants (mean age: 29.13+/- 7.74 years; BMI: 26.39 +/- 6.92 kg/m^2) were eligible for inclusion within this independent report. The demographic and anthropometric data of these participants are presented below (table 1).

TABLE 1: PARTICIPANT DEMOGRAPHICS

DEMOGRAPHICS	MEAN (SD)	RANGE
AGE (YEARS)	29.13 (7.74)	20-49
HEIGHT (M)	1.74 (8.73)	1.62-1.89
WEIGHT (KG)	80.17 (22.52)	50-129.7
BMI (KG/M^2)	26.39 (6.92)	17.78-41.63
GENDER	9 Males / 6 Females	

TABLE 2: PARTICIPANT INITIAL ASSESSMENT

<table>
<tr><td>EXPERIENCE OF REGULAR DISCOMFORT</td><td>Never = 7.14%
Rarely = 28.57%
Sometimes = 64.29%
Very Often = 0%
Always = 0%</td></tr>
<tr><td>NEED TO REPOSITION SEAT</td><td>Never = 7.14%
Rarely = 14.29%
Sometimes = 28.57%
Very Often = 50.00%
Always = 0%</td></tr>
<tr><td>TROUBLE SITTING UPRIGHT</td><td>Never = 14.29%
Rarely = 28.57%
Sometimes = 14.29%
Very Often = 28.57%
Always = 14.29%</td></tr>
<tr><td>CURRENT SEATING AFFECTS ABILITY TO FUNCTION/CONCENTRATE</td><td>Never = 21.43%
Rarely = 50.00%
Sometimes = 28.57%
Very Often = 0%
Always = 0%</td></tr>
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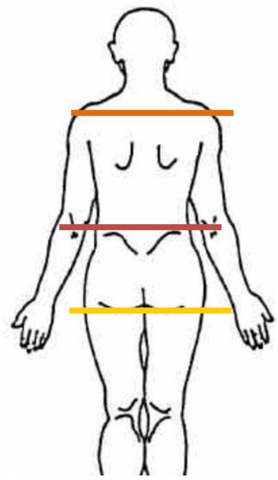
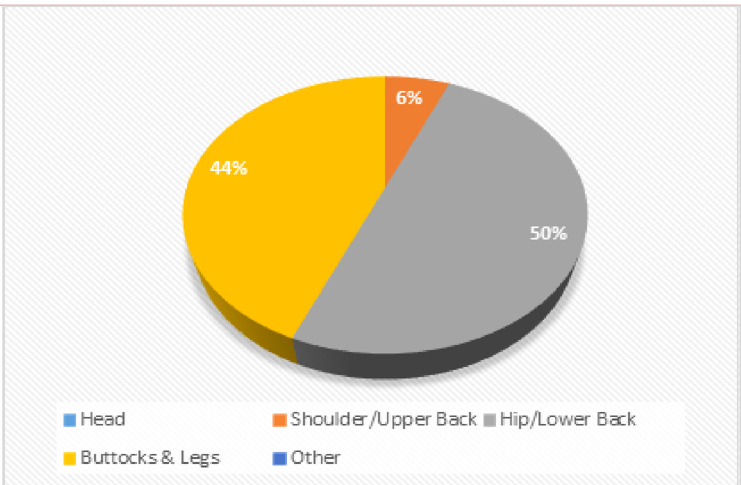
<tr><td></td><td>
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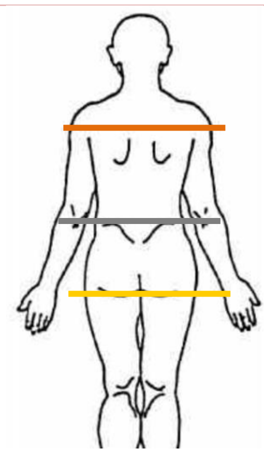
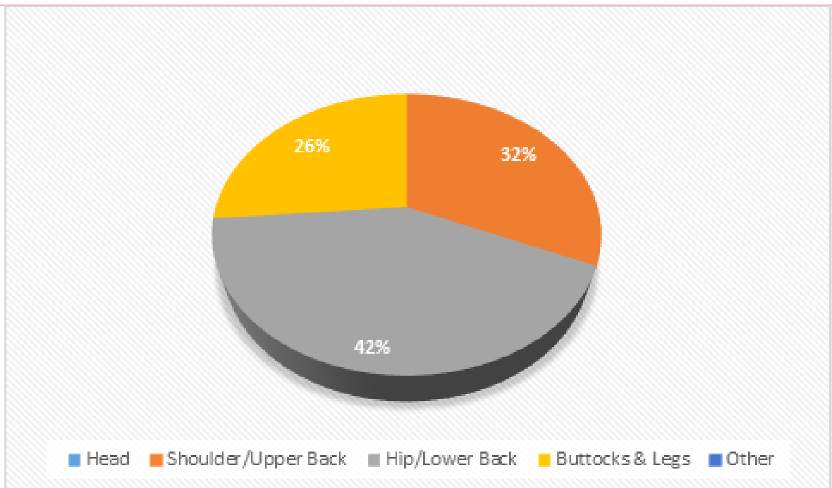
<tr><td colspan="2">WHERE OFFICE CHAIRS SHOULD BE MOST SUPPORTIVE</td></tr>
<tr><td></td><td>
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Table 3: Peak Pressures

Peak Pressure (KPa) Mean (SD)	Intervention		
	Standard Chair	Apex Chair 0°	Apex Chair 8°
Peak Pressure	9.47 (4.27) 9.43 (4.05) 9.62 (3.77) 9.55 (4.23) 9.40 (3.58)	8.21 (3.93)b 8.83 (4.46) 9.07 (5.05) 9.26 (4.99) 9.33 (5.14) a	9.49 (5.08) 9.83 (5.36) 10.11 (4.99) 10.65 (5.31) 10.78 (5.08) a
Left Anterior	3.70 (1.40) 3.77 (1.36) 3.90 (1.49) 3.88 (1.64) 3.94 (1.31)	3.59 (0.69) 3.74 (0.79) 3.91 (0.99) 3.78 (0.83) 3.81 (0.79)	3.69 (1.08) 3.62 (1.03) 3.83 (1.15) 3.80 (1.17) 3.79 (1.19)
Left Posterior	8.90 (4.40) 9.12 (4.14) 9.29 (3.85) 9.14 (4.37) 9.02 (3.70)	7.77(4.10) 8.25 (4.68) 8.69 (5.11) 8.64 (5.18) 8.85 (5.26)	9.02 (5.20) 9.22 (5.47) 9.40 (5.12) 9.85 (5.63) 9.83 (5.42)
Right Anterior	3.59 (0.99) 3.59 (0.86) 3.62 (0.75) 3.55 (0.79) 3.63 (0.91)	3.61 (0.76) 3.69 (0.81) 3.75 (0.95) 3.82 (0.93) 3.74 (1.00)	3.47 (0.97) 3.50 (1.04) 3.73 (1.09) 3.69 (1.18) 3.60 (1.13)
Right Posterior	8.11 (3.74) 7.54 (3.14) 7.77 (3.30) 7.70 (3.09) 7.74 (2.80)	6.97 (3.02) 7.24 (3.00) 7.08 (2.78) 7.32 (2.35) 7.22 (2.67)	8.0113 (3.52) 8.2140 (3.01) 8.3700 (3.25) 8.9653 (3.25) 8.81(2.92)

a denotes a significant difference in peak pressures over start and end times
b denotes a significant difference between peak pressure between chairs

3.2 Seating Peak Pressure

The peak pressure were recorded underneath the buttock and thighs where the participant was in contact with the chair. The mean peak pressures for each intervention are displayed in Table 3.

Which of the interventions reduced peak pressure?

Table 3 demonstrates the highest mean peak pressure was recorded for the Apex chair 8° (10.78KPa) with the lowest mean peak pressure found at Apex chair 0° (8.21KPa). There were significant differences in peak pressure ($P<0.05$) found between the Apex chair 0° and the other seats. The tilt increased pressure the posteriorly and off loaded pressures anteriorly. There was no statistically significant difference between the left and the right posterior quadrants.

3.3 BIOMECHANICAL DATA

TABLE 4: ALL SPINAL DATA (UT = Upper Thoracic; MT=Mid Thoracic; LT=Lower Thoracic; UL=Upper Lumbar; LL=Lower Lumbar; Pel=Pelvis.

ANGLE (˚)	INTERVENTION		
	STANDARD CHAIR	APEX CHAIR 0°	APEX CHAIR 8°
SAGITTAL PLANE			
UT-MT	-37.22 (23.27)	-36.36 (22.89)	-37.49(22.90)
MT-LT	-5.57 (20.35)	-5.11 (20.93)	-5.80 (21.03)
LT-UL	6.93(23.26)	6.76 (22.52)	6.90 (23.15)
UL-LL	-9.90 (17.92)	-11.10 (14.89)	-9.75 (18.81)
LL-PEL	-3.49 (25.14)	-5.16 (26.52)	-7.11 (25.89)
CORONAL PLANE			
UT-MT	-0.46 (10.02)	-0.82 (9.79)	-1.30 (9.64)
MT-LT	0.65 (5.81)	0.27 (5.71)	.30 (5.83)
LT-UL	-0.34 (5.82)	-0.62 (5.33)	-0.63 (5.49)
UL-LL	2.52 (8.74)	1.10 (8.52)	0.11 (7.91)*
LL-PEL	-0.24 (6.39)	-1.26 (7.18)	0.34 (8.16)
TRANSVERSE PLANE			
UT-MT	0.80 (6.06)*	1.89 (6.12)	1.74 (5.72)
MT-LT	0.82 (3.05)	1.21 (2.93)	1.18 (3.13)
LT-UL	-1.48 (6.59)	-2.20 (6.67)	-2.05 (6.16)
UL-LL	0.31 (5.24)	-.181 (4.38)	0.13 (4.83)
LL-PEL	3.63 (5.77)	3.35 (5.67)	4.39 (4.50)

Table 4 demonstrates that significant changes in the coronal plane (sideways movement) at the upper lumbar and lower lumber, with the Apex chair tilted causing a significant change (P>0.05) in the angle between these two sections. The results signify that with the tilt the participants were sitting closer to a neutral position with the tilt when compared to the other sitting conditions. In the transverse plane (rotation) at the angle between the upper thoracic and mid-thoracic the participants adopted a more neutral position

3.4 POST-INTERVENTION QUESTIONNAIRES

TABLE 5: PARTICIPANT REPORTED OUTCOME MEASURES POST INTERVENTION

	INTERVENTION		
	STANDARD CHAIR	APEX CHAIR 0°	APEX CHAIR 8°
COMFORT (0=VERY UNCOMFORTABLE, 10=VERY COMFORTABLE)	5.72 (1.66)*	7.03 (1.29)*	6.83 (1.94)*
FIRMNESS (0=SOFT, 10=FIRM)	5.72 (1.45)	6.67 (1.75)	6.38 (1.68)

*Denotes significant differences between interventions

Which of the interventions is more comfortable?

After each intervention (standard chair, Apex chair 0° and Apex chair 8°), each individual scored it based on comfort on a numerical rating scale (0=very uncomfortable, 10=very comfortable). Table 5 demonstrates that significant differences were found between all interventions ($P<0.03$), with Apex chair 0° found as the most comfortable.

Which of the interventions is perceived as more firm?

After each intervention (Standard chair, Apex chair 0° and Apex chair 8°), each individual scored it based on firmness on a numerical rating scale (0=very uncomfortable, 10=very comfortable). Table 4 demonstrates that no significant differences were found between interventions, with Apex chair 0° found as the firmest and the standard chair the softest.

Subjective Preference/Feedback

Once all interventions had been tested, the participants were asked to rank the three interventions in order of preference. The feedback is summarised in Figure 7 below.

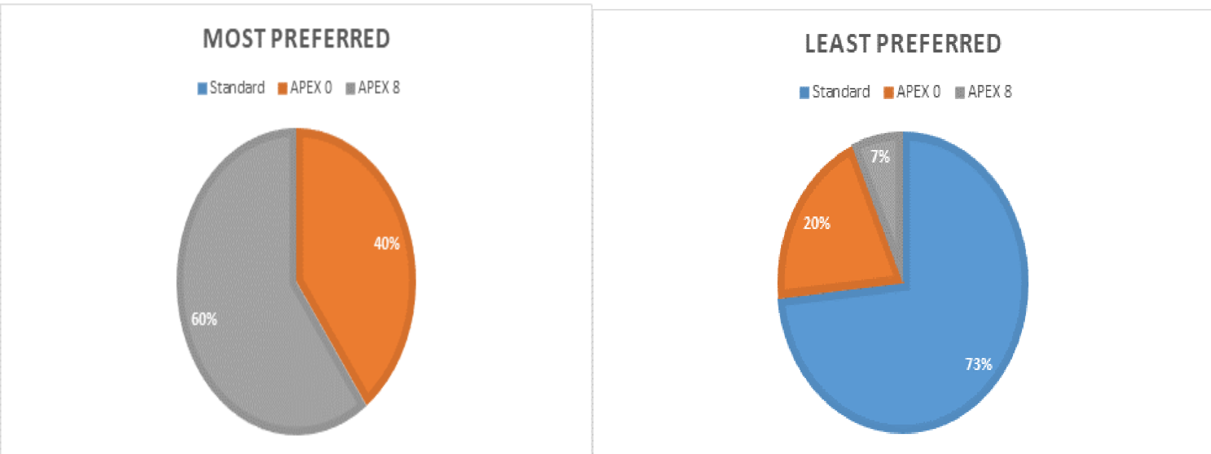

Figure 7: A summary of the participants 1st, 2nd and 3rd choice intervention preference during the study

Which of the interventions is the most preferred?

Figure 7 shows the number of participant votes for 1st, 2nd and 3rd preference. Apex 8° was found to be the most preferred seating solution with 60% of participants selecting this as their first choice, closely followed by the Apex chair 0° with 40% of participants. The standard chair was the least preferred intervention for 73% of participants, followed by the Apex 0° (20%) and finally the Apex 8° (7%).

4.0 SUMMARY

The data collected was ranked, from three to one, to give each seating solution a performance score in that category. A score of three was given for the seating solution that performed the best and a score one for the seat that performed the worst.

	STANDARD CHAIR	APEX CHAIR 0°	APEX CHAIR 8°
COMFORT	1	3	2
FIRMNESS/ SUPPORT	1	3	2
PREFERENCE	1	2	3
SPINAL POSTURE	1	2	3
TOTAL PEAK PRESSURE	2	3	1
LEFT POSTERIOR PEAK PRESSURE	2	3	1
RIGHT POSTERIOR PEAK PRESSURE	2	3	1
LEFT ANTERIOR PEAK PRESSURE	2	3	1
RIGHT ANTERIOR PEAK PRESSURE	2	1	3
TOTAL SCORE	14	23	17

Overall the Apex chair with no tilt was most effective seating solution when considering all the aspect tested with the standard chair being the least effective. It should be noted the performance of the chairs would change with the backs of the chairs being used as this will offer additional support to the users.

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