INNOVATIVE LUMBO-PELVIC SEATING CUSHION TO IMPROVE LUMBO-PELVIC POSTURE DURING SITTING IN OFFICE WORKER

WITTHAWIN SAE-LEE

Graduate School Srinakharinwirot University

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นวัตกรรมเบาะหนุนรองนั่งเพื่อช่วยปรับปรุงท่าทางของกระดูกสันหลังส่วนเอวและกระดูกเชิงกราน
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WITTHAWIN SAE-LEE

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INNOVATIVE LUMBO-PELVIC SEATING CUSHION TO IMPROVE LUMBO-PELVIC POSTURE DURING SITTING IN OFFICE WORKER

BY

WITTHAWIN SAE-LEE

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(Assoc. Prof. Dr. Chatchai Ekpanyaskul, MD.)

Dean of Graduate School

ORAL DEFENSE COMMITTEE

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(Asst. Prof.Pattariya Intolo, Ph.D.)	(Asst. Prof.Montakarn Chaikumarn, Ph.D.)
.... Co-advisor	.... Committee
(Asst. Prof.Nattapong Kongprasert, Ph.D.)	(Assoc. Prof.Rumpa Boonsinsukh, Ph.D.)

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Author	WITTHAWIN SAE-LEE
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Thesis Advisor	Assistant Professor Pattariya Intolo , Ph.D.
Co Advisor	Assistant Professor Nattapong Kongprasert , Ph.D.

Presently, office workers tend to sit for longer periods of time. More than half of all office workers have lower back symptoms or disorders as a pain indication. This pain is caused by a change in sitting posture in the lumbar and pelvic areas when sitting for a while. The seat cushion plays a role in adjusting the chair by increasing the seat pan inclination to improve anterior pelvic tilting of the pelvis. This study aimed to design an innovative seat cushion related to ergonomic design and improved sitting posture by promoting the anterior pelvic tilt and lumbar lordotic curve. As a result, two new seat cushions were developed. Then, the new seat cushion design was conducted to compare the use of no seat cushion when sitting in an office chair. Thirty-six healthy prolonged sitting office workers were analyzed and performed on the kinematics and pain scale. All participants were randomly assigned a sequence of sitting trials and scored the pain intensity by using a Visual Analog Scale (VAS). The placement of kinematic markers was used to assess and measure the lumbar and pelvic tilting angles. The pain score and interesting angles were compared at each trial as sitting on the chair with the addition of three various seat cushion designs. The results illustrated that the new seat cushion could improve sitting posture and also reduce pain in the lower back region.

Keyword : ergonomics design, seat cushion, sitting posture, anterior pelvic tilting

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CHAPTER 1
INTRODUCTION

Background

Currently, human beings tend to suffer from extended periods in seated positions due to an increase of office work time and, more specifically, time devoted to advanced technology: I.e. computers and gaming devices. Through technological devices (such as computers and gaming devices) human beings thus reach a euphoric state. The convenience of advanced technology beings at their fingertips, which eventually becomes a detriment to their physical well-being due to the fact that they remain seated throughout these euphoric experiences.

In 2016, Thailand National Statistical Institute found that 14.4 million Thai people used computers daily, in which working age groups cover approximately 71.2 percent of that (1). Data on office workers demonstrated that 48.8 percent were in prolonged sitting positions during computer use (2). These office workers reported feeling pain throughout their body after some time during the process. They required adjusting their sitting positions to help alleviate aches and pains. It has also been reported that 66.3 percent of this group bracket experienced pain, particularly at the back region (3). This is related to the study of Daneshmandi et al, in 2017, which found that 53.2 percent of the computer users, with a prolonged sitting duration of roughly6.29 hours per day, reported back pain (2). In addition, they conveyed that continued prolonged sitting is also associated with intense low back pain (4-6). Similarly, poor sitting posture, or “half-sitting”, is also a major risk factor to back pain (OR =2.241 P=0.001) (7).

Prolonged sitting duration is considered to be a risk factor that can change sitting positions from good posture to poor posture (8, 9), which ultimately leads to back pain. Waongenngarm et al, 2015 showed that prolonged sitting with slumped posture provoked a low back pain score(10). Another research paper has similarly displayed that poor posture in the neck region induced back pain with increased muscle activity and interdiscal pressure on the spine (11).

Poor sitting posture and sitting in long duration are possible cause of back pain and, it probably cannot control the sitting duration while working. The previous study found that sitting posture tended to be poor after sitting for a while (12). Thereby, correction of sitting posture is one of the best way to prevent and solve back problem. Interestingly, there was an evidence which found that erect sitting showed in range from posterior pelvic tilting of 3 degrees to anterior pelvic tilting of 10 degrees and lumbar lordosis approximately 4.4 degrees (13).

At present, knowledge of ergonomics is an important role in improving sitting posture, which enables prevention of back pain for a vulnerable population. Changing the arrangement of the workspace can reduce pain and improve sitting postures (14). Adjustment of working desk, computer/screen placement, and chair are recommended. These adjustments are helpful in significantly reducing neck and upper body pain. In addition, adjustment of chairs could decrease pain scale at the back region, and also improve lower back posture. Previous studies also found that such modifications of the chair itself were effective in reducing pain during working hours in front of a computer.

Adjustable chairs, which are more ergonomically sound. Two main things including backrest and seat pan inclination adjustment are the effectiveness which lead to the improvement of sitting posture and pain during sitting. however, an expensive purchase for a computer user, both in office and at home. In addition, there are further limitations to this, such as company regulations, working characteristics or financial limitation, etc. Seat cushions and backrest supports are coming into play to help modify chairs in accordance with ergonomic recommendations. Some studies showed that using backrest supports or back care pillows can help reduce pain intensity (15, 16). However, there are a few studies evaluating effect of seat cushions on improvement of sitting posture in term of lumbar curvature and pelvic tilting and back pain reduction in sitting.

Interestingly, seat cushions are more affordable and practical as they are portable and can be fitted to many chair designs. It had been found that seat cushions on the commercial market were still being unwieldy and importable. There is also little evidence to show that seat cushions can help prevent pain, and improve lumbo-pelvic angles during short and long sitting sessions in front of a computer (17). At present, there is no official study evaluating the effects of seat cushions on lumbo-pelvic posture and pain during prolonged sitting. Therefore, it is vital that an ergonomic seat cushion is designed, based on knowledge of anatomical, biomechanics and ergonomics in order to help office workers who work with computers experience a pain free prolonged sitting session. It probably that the design of commercial seat cushions is lacking or not relating to ergonomic method of seat pan inclination adjustment. In regard to the statements above, there is expected to be sufficient gaps of research on this particular subject. Therefore, the aim of this study is to prove the new design of seat cushion which relate to ergonomic method to prevent low back pain and correct lumbo-pelvic posture in short duration of sitting in office worker comparing with no use any seat cushion. This study was developed 2 designs of the seat cushions. Three experts in human biomechanics and engineering were evaluated the new seat cushion designs by using Pugh matrix method to generate and determine the innovative design against the existing designs. Afterward, they discussed about phototype to finalize the new seat cushion designs. The first seat cushion will be created related to inclination of seat pan referenced from ergonomic seat chair adjustment which will be named as Pelvic seat cushion design. The second seat cushion will be created related to applied posterior height of seat cushion which will be named as Lumbo-pelvic seat cushion design.

Research Questions

Which seat cushion design can induce 10 degrees of anterior pelvic tilting to 3 degrees of posterior pelvic tilting?

What is the difference of perceived pain intensity among pelvic seat cushion design, Lumbo-pelvic seat cushion design, and no cushion?

Objective

General objective

To compare the lumbar angles, pelvic tilting angles and perceived pain intensity among pelvic seat cushion design, Lumbo-pelvic seat cushion design, and no cushion in sitting

Specific objective

To compare the lumbar angles pelvic tilting angle among pelvic seat cushion design, Lumbo-pelvic seat cushion design, and no cushion in sitting at 0 and 10 minutes

To compare the perceived pain intensity among pelvic seat cushion design, Lumbo-pelvic seat cushion design, and no cushion in sitting at 0 and 10 minutes

Research hypotheses

Lumbar angle and pelvic tilting angle in pelvic cushion design and Lumbo-pelvic seat cushion design will be better than no cushion in sitting at 0 and 10 minutes.

Perceived pain intensity in pelvic cushion design and Lumbo-pelvic seat cushion design will be lower than no cushion in sitting at 0 and 10 minutes.

Scope of the study

This research conducted within a working age group who has experience in prolonged sitting durations of at least 6 hours per day and longer than 41 hours per week (3).

Research Advantages

Obtain the evidence of comparing of lumbar angles pelvic tilting angle and perceived pain intensity among using 2 seat cushions and no used.

Develop one prototype innovative seating cushions to improve lumbo-pelvic posture and prevent pain in office workers.

Conceptual framework

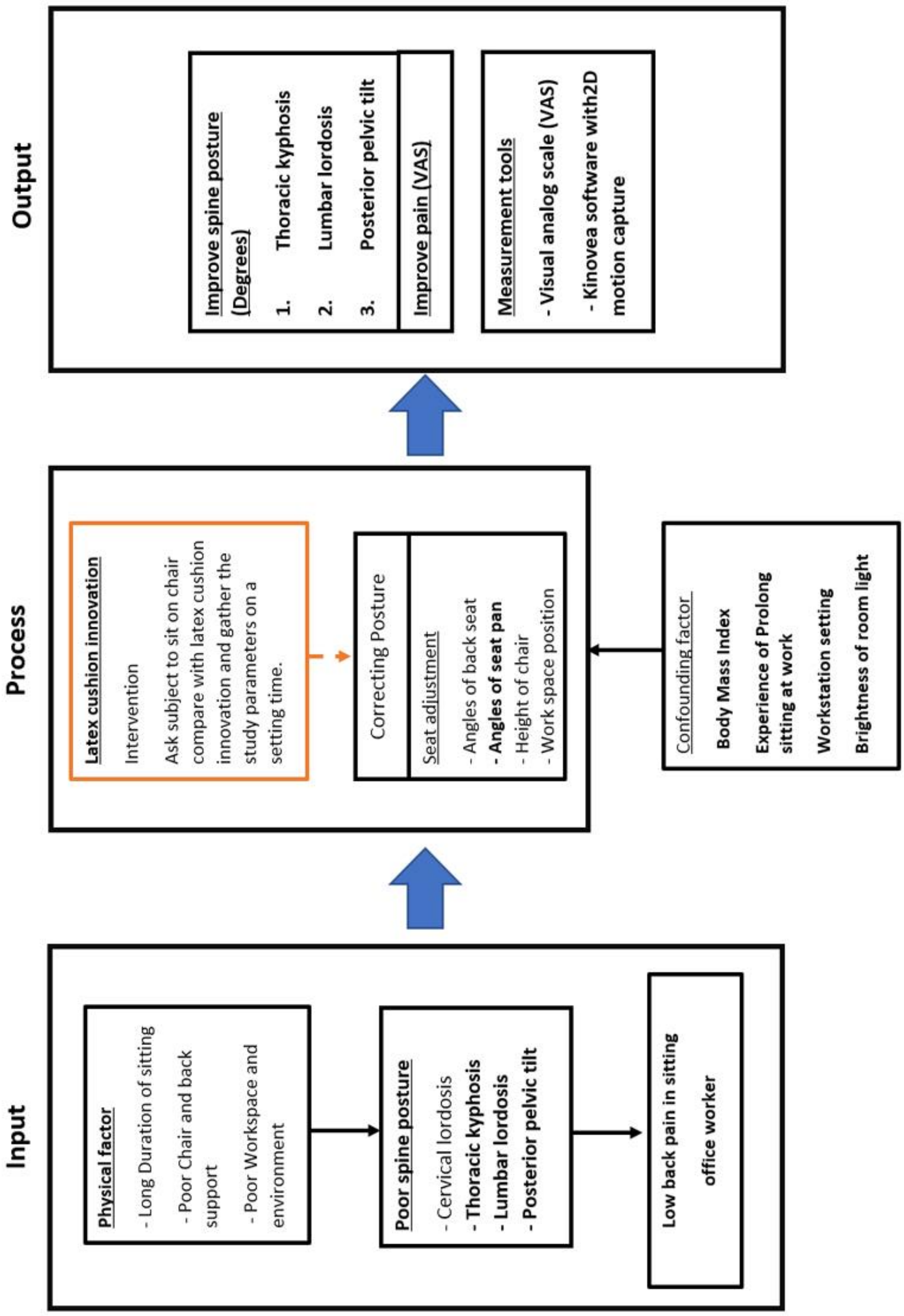

Figure 1 Conceptual framework of this study

CHAPTER 2
LITERATURE REVIEW

The review of literature includes the following categories

Back pain in office worker cause of prolong sitting

Spine and pelvic posture in sitting position

Ergonomic guideline of Computer Workstation

Chair adjustments help to correct posture

Seat Pan inclination adjustment

Backrest adjustment

Seat cushion help to correct posture and reduce back pain

Seat cushion material

Prototype evaluation

Outcome measurement

Pain measurement

Pelvic inclination and lumbar curve measurement

VICON 3D Motion Analysis

Flexible Electrogoniometer

Kinovea 2D Video capture

Back pain in office workers during long duration sitting

Low back pain symptoms are commonly found as one of the physical factors caused from poor posture in prolonged sitting in front of a computer. It was reported that 46.9 percent of Thai university office workers had low back pain (LBP). In addition, this group of office workers reported that LBP affected their quality of life and working performance (18). Interestingly, it was also found that about 122 in 173 office workers with chronic LBP tended to work with poor posture (19).This corresponded with results of a study from Hanna et al 2019, who found that the sedentary behavior of around 6 hours per day was associated with back pain in university employees (aOR = 1.74, 95% CI =1.19-2.57) (20). A study of bank officers who work full-time, 8 hours a day, reported that the prevalence of back pain was 45.8%. This study was drawn from workers who did not have breaks during their working day (aOR=3.96; 95% CI = 1.71-9.20; p,0.0001) (21). Therefore, prolonged sitting could be considered a risk factor of LBP.

Spine and pelvic posture in sitting position

Poor posture was found in prolonged sitting with posterior pelvic tilt and decreasing lumbar lordosis. Morl et al, in 2013 found that sitting longer than 10 minutes showed an increasing lumbar flexion angle at around 4-12 degrees. This finding indicated that the reduction of lumbar lordotic curve showed a flat back of the lumbar region and slumped posture (12). Similarly, Claus et al, in 2016 found that, without postural correction after sitting for 10 minutes, spine posture reached into slumped back or relaxed sitting posture (9) (Figure 2).

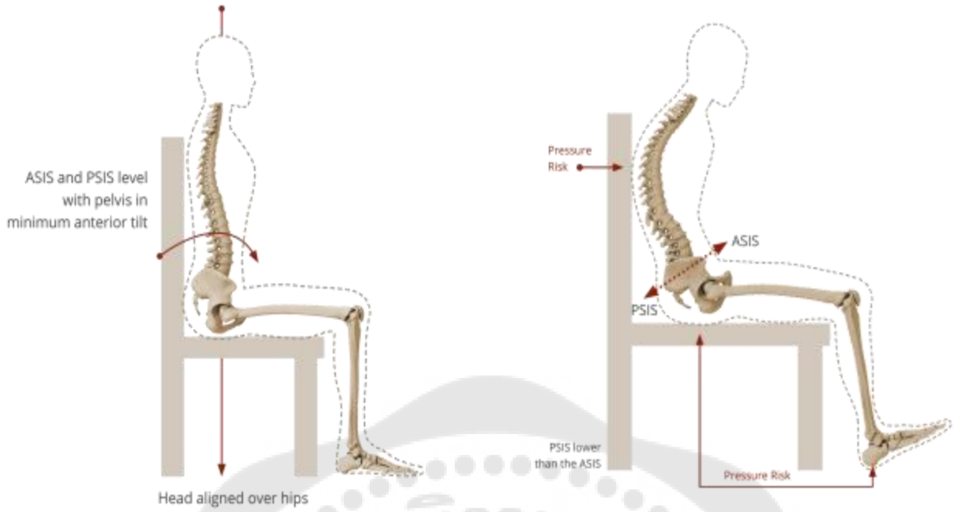

Figure 2 Straight and slouch sitting postures

Kinematic chain of skeletal system was related and connected to the whole body. Postural changing in one joint influenced nearby joints. Pelvic tilting effects lumbar angle in biomechanical principle, human with anterior pelvic tilt could increase lumbar lordosis, and humans with posterior pelvic tilt could decrease lumbar lordosis (Figure 3).

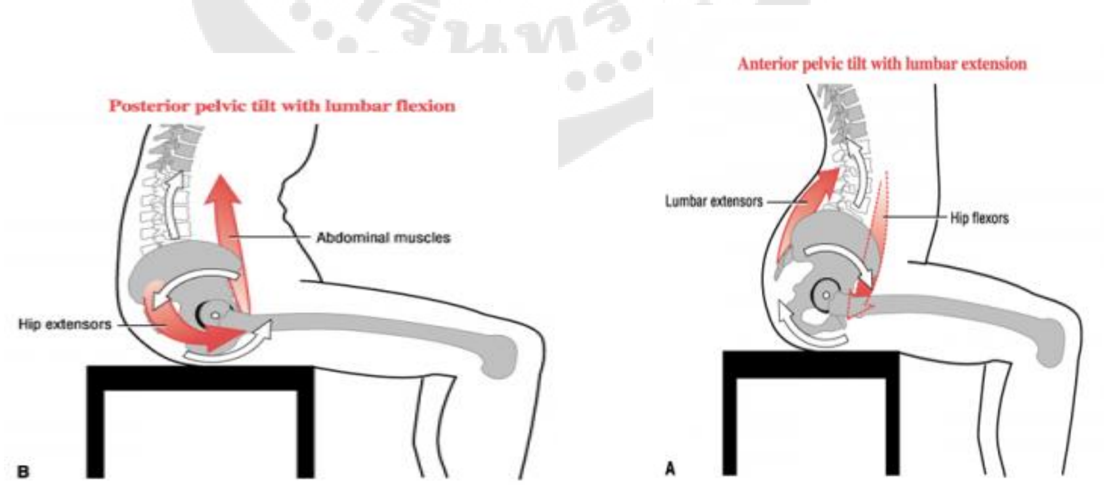

Figure 3 Main muscle activity during pelvic tilting movement

Yu et al, 2015 evaluated pelvic and lumbar angles during sitting in erect sitting, slouched sitting and crossed leg sitting positions in healthy adult females. The results clearly showed that erect sitting posture induced 3.07 degrees of pelvic tilting and 4.4 degrees of lumbar (13). Preece et al, 2008 measured the pelvic tilting angle, defined as the angle of PSIS to ASIP, which found that the pelvic tilting angle was at an average of 13 degrees with a standard deviation of 5 degrees (22). Obviously, sitting with slouched posture significantly displayed a higher posterior pelvic tilt than sitting in an upright posture ($P<0.001$) (13, 23, 24). Moon et al, 2018 showed that in sitting, sacral slope decreased 15 degrees when compared with a standing posture (25). A sitting position reduced the anterior tilting angle. Likewise, decreasing of lumbar lordosis had a strong correlation with decreasing sacral slope or pelvic inclination ($r= 0.731$, $P<0.01$) in relaxed sitting (26). Therefore, poor sitting posture is not only decreasing the lumbar lordotic, it is also decreasing the anterior pelvic tilt angle (23).

From previous studies, it can be concluded that poor sitting posture indicated a posterior pelvic tilt and reduced lumbar lordosis. The poor sitting posture for prolonged periods induced back pain in up to 71% of office workers (27). In addition, poor sitting posture can lead to overall negative effects, particularly in long duration. Therefore, in order to prevent and resolve poor sitting postures, good body mechanics with promoting an anterior pelvic tilt is crucial. Poor sitting postures not only produce abnormal pelvic and lumbar curvature, but also affects muscle activity. It was found that muscle activity of Lumbar multifidus, Internal oblique, Thoracic erector, External oblique, Rectus abdominis and Iliocostalis muscle in slumped positions was significantly higher than sitting upright postures ($p<0.05$) (23).

Heyet al, in 2017 found that people who already suffer from LBP had a less lumbar lordotic curve at about 21-22 degrees compared with a regular, healthy group of people (11). Similarly, Emanuelle et al, in 2011 found that people who have back pain experience tended to have a decreased lumbar lordotic curve (28). Therefore, the current study will recruit asymptomatic LBP to consider the confounding factor cause of LBP.

Ergonomic Guideline of Desktop Computer Workstation

In addition, with sitting in good posture in front of a computer, the adjustment of the workstation has to also be considered. The United State of Occupation Safety and Health Administration (OSHA) recommended an ergonomic principle checklist for desktop computer workstations that was developed and approved by OSHA (Figure 4). Full checklist is already attached in the Appendix.

Computer Workstations eTool

Checklists » Evaluation

This checklist can help you create a safe and comfortable computer workstation. You can also use it in conjunction with the purchasing guide checklist. A "no" response indicates that a problem may exist. Refer to the appropriate section of the eTool for assistance and ideas about how to analyze and control the problem.

Print Checklist

WORK STATIONS - Arrange and adjust the computer workstation to promote neutral postures.	**Y**
1. Head and neck are balanced and in-line with torso (ears directly above the shoulders not bent forward or back). If "no" refer to Monitors, Chairs and Work Surfaces.	☐
2. Head, neck, and trunk facing forward (not twisted to view monitor/work/documents). If "no" refer to Monitors or Chairs.	☐
3. Torso is vertical to slightly reclined (see recommendations in Good Working Postures). If "no" refer to Chairs or Monitors.	☐
4. Back is fully supported by chair lumbar support. If "no" refer to Seating.	☐
5. Shoulders are relaxed (not elevated). Upper arms Shoulders are relaxed (not elevated). Upper arms are in-line with torso, (not elevated or stretched forward unless supported by work surface). If "no" refer to Chairs.	☐
6. Elbows are close to the body (not extended forward or outward unless supported by work surface or chair armrests). If "no" refer to Chairs, Work Surfaces, Keyboards, and Pointers.	☐
7. Forearms are approximately parallel to the floor and about 90 to 100 degrees to the upper arm. If "no" refer to Chairs, Keyboards, Pointers.	☐
8. Wrists and hands are straight in alignment to the forearm (not bent up/down or sideways). If "no" refer to Keyboards, or Pointers	☐
9. Thighs are approximately parallel to the floor (and lower legs are approximately perpendicular to floor (thighs may be slightly elevated above knees see recommendations in Good Working Posture for declined seated postures). If "no" refer to Chairs or Work Surfaces.	☐
10. There should be sufficient room under the work surface so thighs have clearance space between the top of the thighs and the computer table/keyboard platform (thighs are not trapped).	☐

Figure 4 Checklist of desktop computer Workstation adjustment developed by OSHA

In addition, three studies recommend adjusting the workstation, similar to the OSHA checklist, which also incorporates ergonomic principles (27, 29, 30). The results showed that after workstation adjustment, pain intensity decreased significantly ($P<0.05$). Therefore, the current study will follow the OSHA guideline to adjust the desktop computer workstation before gathering data to evaluate the results of the innovative seat cushion to help remove the effect of confounding factors.

Effect of Posture correction by chair adjustment

Literature review in this point will be part of consideration to design an innovative seat cushion. Improvement of sitting posture in office workers involves adjusting workspace, including computer desk and chair. Adjustment of chair is considered important in two parts, including seat pan inclination and backrest.

Seat pan inclination adjustment

Seat pan inclination helps to improve anterior pelvic tilt to promote a normal lumbar curvature. A study found that the 10 degrees seat pan tilting promoted anterior pelvic tilting, and improved lumbar lordosis (30). Moreover, it also found that seat pan adjustment, with tilting forward, reduced low back pain when compared to no adjustment. Interestingly, adjustment of seat pan reduced and delayed the occurrence of low back pain during 1 hour prolonged sitting (31).

Backrest adjustment

In terms of backrest adjustment, Curran et al, in 2014, found that backrest height located at 22 cm behind greater trochanter at level of posterior superior iliac crest (PSIS) increased comfort feeling when compared with no back rest support (32) (Figure 5). In addition, using the lumbar care pillow at the lower back region reduced LBP intensity when compared with only using lumbar support during 2 weeks study (16). However, a study found that a backrest did not substantially help reduce back pain after adjustment (15).

Figure 5 Sitting posture with and without adjustable backrest (32)

Seat cushions help to correct posture and reduce back pain

There are a few seat cushions designs which are available on the market which had been evaluated in terms of preventing pain in sitting postures. It is found that two particular cushion designs did not help to reduce low back pain after sitting longer than 10 minutes (33). The weak point of the cushion designs may be that the participants were unable to maintain an upright posture while seated, in spite of the first cushion design recommended for participants with the weight of around100 pounds (about 53 kg). In addition, the study that was designed to gather pain detection was quite short in time duration. They were 0, 6, 12 minutes, which is an inappropriate study time for prolonged sitting. A previous study involved designed short wedge shape seat cushions (depth 30 cm with slope of 10 degrees) which did not help to correct posture, and it promoted posterior pelvic tilting at 3-13 degrees, instead of anterior pelvic tilting. However, this study was examined in crossed sitting posture which is in a different body mechanic for chair sitting (27) (Figure 6).

Figure 6 Lumbo-pelvic posture in crosses sitting posture (27)

In conclusion, there is no ergonomic seat cushion designed that truly considers biomechanics of sitting posture, particularly normal pelvic tilting and lumbar lordotic curvature and it bears no scientific improvement in angle and pain in prolonged sitting.

Seat cushion material

At present, seat cushion industries try to produce comfortable cushions to distribute and sell in trade-wars. Apart from the cushion design itself, the material is one of the main important factors for manufacturing of seat cushions. It has been found that a lot of material types are developed in these industries. The most popular features are the softness of the materials. Gel and foam material were considered to be used in previous studies. It was possible that mostly a seat cushion is manufactured by using gel and foam. Interestingly, latex rubber is one of the materials that is very popular in the mattress industry, particularly in Asia because of the cultivation ability of this region. From Low et al, 2017 found that the mattress with latex material could reduce peak pressure and improve pressure distribution while asleep in different postures, including supine, prone, side-lying (34). Latex has a different density, including hard, firm, soft, to help develop support, conform different parts of the body, such as seven zones latex mattress which has a firm density to support the pelvic region but a low density to support the leg region. Other implicated studies' results displayed the same data. The study used neutral rubber latex to produce health care and a therapeutic applicator. A wheelchair seat was manufactured by using neutral rubber latex and the study found that it could reduce peak pressure better than normal wheelchairs (35).

It can be seen that latex is an effective material in developing an innovative seat cushion. However, latex properties, such as density, recoil force, collapse ability, elasticity etc., varies depending on the latex mixed formula. Those qualities are produced from the intellectual property of different companies.

Prototype design evaluation

Prototypes are generally the first or preliminary draft toward to a final concept of a production. Innovative products must be developed from prototypes in order to test the existing design and/or design flaws. Prototype Evaluation is used for testing prototypes to help confirm that the product has an innovative functionality prior to production. Additionally, prototypes are typically created in various designs to offer the best options for designers prior to evaluating the objective functionality of the product by using the Prototype Evaluation Process. Too many wireframed paper prototypes could waste the prototype evaluation costs. The prototype design should be taken into consideration by choosing the most appropriate and best design for the mocking up and the evaluation stages.

Pugh matrix is a type of Matrix diagram that allows comparison of a number of design candidates which meet a set of criteria by comparing prototype designs with their baseline or previous designs. This matrix diagram is widely used in making the final decision on the prototype design. The basic concept of the Pugh matrix is easy to understand. The clearly identified criteria must be included into the diagram. The scoring for each criterion is "+" for each criterion where the prototype design better than the baseline, "-" for each criterion where the prototype design is worse than baseline, and "S" for each criterion where the prototype design is the same as the baseline. It is also possible to add extra levels of discrimination by using "++" for "much better" and "--" for "much worse" for each criterion (36) (Figure.7).

	Design Concept A	Design Concept B	Design Concept C	Design Concept D	Design Concept BC	Design Concept BD
Criteria 1	S	+	S	+	+	+
Criteria 2	S	-	S	+	S	+
Criteria 3	S	S	S	+	S	+
Criteria 4	S	-	+	+	+	+
Criteria 5	S	-	+	+	+	+
Criteria 6	S	-	S	-	S	-
Criteria 7	S	+	S	-	+	+
Criteria 8	S	+	S	-	+	+
Criteria 9	S	-	S	-	S	-
Criteria 10	S	S	-	S	S	S
TOTAL +	0	3	2	5	5	7
TOTAL -	0	5	1	4	0	2
TOTAL SCORE	0	-2	1	1	5	5

Figure 7 A completed Pugh matrix for the alternative designs

Before completing the diagram, the criteria must be weighted to give the order of the criteria's magnitude from the relevant person. Typically, the weighting score is on 1 to 5 scale which 1 is the lowest and 5 is the highest weighting for each criterion (Figure 8).

				Design Concepts				
		Pugh Concept Selection Matrix	Wieght	Electric 4-slot	Electric Conveyor	Gas Grill		
Selection Criteria	Good Toast Quality	Even Toasting	2	S	S	-		
		Good Taste	3	S	S	S		
		Repeatable	3	S	+	-		
		Quick	3	S	S	S		
	Capacity	Large Range of Bread Products	2	S	S	+		
		Multiple Slices/Units	4	S	+	+		
	Long Life	Reliable	1	S	-	S		
		Durable	3	S	S	S		
		Low Maintenance	3	S	-	S		
	Physical Attributes	Affordable	2	S	-	+		
		Attractive	5	S	-	-		
		Safe	3	S	-	- -		
		Good Size	4	S	-	-		
	Easy to Use	Easy to use Controls	5	S	S	+		
		Easy to Load	4	S	+	+		
		East to RemoveToast	4	S	+	-		
		Automated	4	S	S	- -		

Figure 8 A completed Pugh matrix with weighted priority of criteria

The score will be calculated by multiplying the weight of criteria to the sign. In order of ‘S’ as ‘0’, ‘-’ as ‘-1’, ‘+’ as ‘+1’, ‘- -’ as ‘-2’ and ‘+ +’ as ‘+2’. Afterwards, summation of the score will be processed into a total score (Figure 9).

TOTAL +		0	4	4		
TOTAL -		0	6	9		
TOTAL SCORE		0	-2	-5		
WEIGHTED TOTAL +		0	15	17		
WEIGHTED TOTAL -		0	17	32		
WEIGHTED SCORE		0	-2	-15		

Figure 9 The total score with completed sum

The total score shows the advances of each prototype design compared to existing design. The chosen prototype design will be refined by recommendation and conclusion of the relevant specialist at the event. In the case of having more than one scorer, all scorers must participate in a meeting to draw the final conclusion on the prototype design.

Outcome measurement

Pain measurement

Pain measurement is one part of the sensations that is mainly objective and reflects some disorder or abnormality inhuman tissue, however many kinds of pain measurements are widely used. Visual Analog Scale (VAS) and numeric pain scale (NRS) are commonly used in pain evaluation in adults. The correlation between two scales and failure rate in pain measurement is 4-11%. Also, VAS and NRS were consistent and had a strong correlation and were coefficient, ranging from 0.97-0.99 (37). A systematic review represented that the most instruments used to indicate pain intensity are VAS and NRS (10 studies in an overall 19 studies). The same systematic review showed that VAS was considered superior than other pain assessments in a 7 from 29 reviews. The other systematic review showed in the same way that a number of studies cited a considerable difficulty in practical use of VAS (38). In the same token, Williamson's study in 2005 also mentioned that VAS had more practical difficulties than NRS and Visual rating scale (VRS) (37), however VAS is statistically the most robust scale as it can provide ratio level data (39). The pain minimum clinical significant difference of VAS and NRS are 12 mm. and 1.39 (40, 41). VAS has more sensitivity for pain than NRS.

Pain in prolong sitting has been used to evaluate pain feeling. However, by using VAS to indicate pain feeling in the previous 2 studies, the results displayed similarities that could detect pain feeling after sitting for 15 minutes in all participant groups neither pain-developer nor non-pain developer (42, 43). Therefore, VAS is more suitable for detecting pain during prolong sitting with and with no cushion use in the current study.

Discomfort measurement

Body part discomfort scale is the other way of measuring discomfort intensity. It was developed in 1976 by Corrett and Bishop, and this scale has been extensively used for seat evaluation prior to 2000 by Fenety et al (44).

Pelvic inclination and lumbar curve measurement

VICON 3D Motion Analysis

3D motion analysis is software that is designed to capture and analyze the biomechanical movement of humans. This process is done by capturing the reflective marker on the body, using a group of infrared video cameras in specified angles, which, in turn, is used to create a 3D model of a joint angle. Despite the fact that it is acceptable to capture the angle and anthropometry, test-retest reliability with traditional anthropometry, ICC were more than 0.7 in their score for the whole body markers, it indicated as a strong correlation between VICON 3D and traditional anthropometry (45). Even though there is no obstruction of viewing of the pelvic and lumbar angles, there are many processes in the camera setting, calibrating the system, and data analyses.

Electrogoniometer

In 1987, flexible electrogoniometer offered the opportunity to investigate spinal kinematic angles during the human number functional movement. This instrument is working to indicate the changing of electrical resistance, proportionally, at the strain gauge which bends and can be calculated into angles. Perriman et al, found that flexible electrogoniometer with strain gauge method concurrent validity had significant correlation with Thoracic region cobb angle measurement from radiography (P>0.05) and also had strong correlation test-retest reliability (0.92-0.95, P-value > 0.001). With the change of electrical resistance, which is a delicate device and easy to be inconvenienced by the disturbance force, could be changing the value of the collected data caused by reverse force by leaning on the backrest (46). However, the placement of electrogoniometer is at the pelvic region which is abstracted by the seat cushion

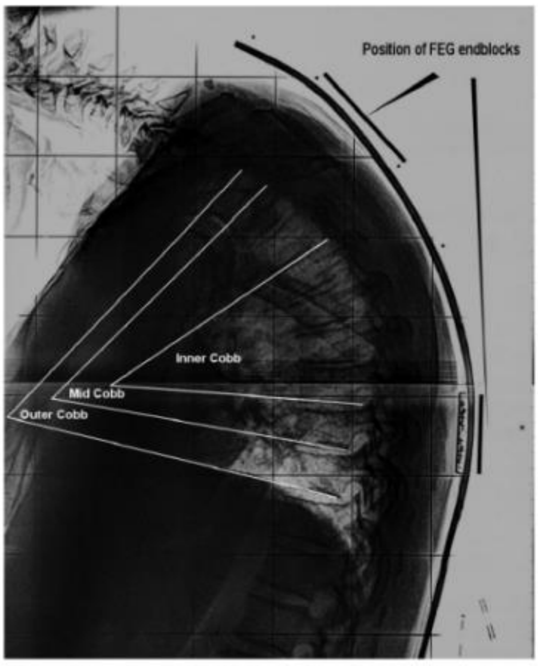

Figure 10 Radiography of thoracic cobb angle with flexible electrogoniometer endblocks

Kinovea 2D Video capture

Kinovea is a video player software for defining angle and movement analysis. It provides a set of tools to capture and measure technical performances by using marking on the attended point. This program is easy to use, and the data validity can be considered acceptable with a correlation value of 1 (ICC =1) in an orthogonal perspective (47). The video camera is perpendicular with the point of interest and data is calculated by plotting the point of interest in the computer program to create the hypothetical line with the angle. The camera can capture pelvic and lumbar angles with no disruption in sitting in front of the computer. Kinovea program has been used widely in many studies due to this fact. Santo Et al, 2017 used Kinovea software to assess the changing in spine curvature while sitting on difference types of chairs (48), Millar et al, 2017 also used Kinovea software to define changing of lumbar curve while chronic LBP people performed trunk flexion. It can be seen that Kinovea software had been used widely to measure lumbar curvature in many situations (49). The Kinovea is a standard device for collecting pelvic and lumbar angle data in this study (Figure 11).

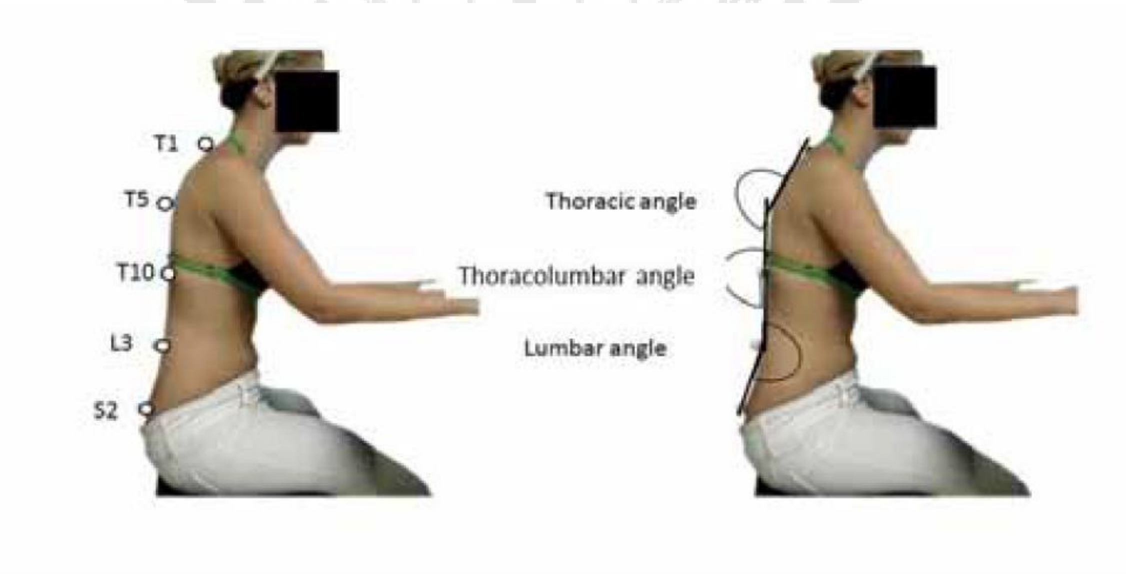

Figure 11 The illustrative image showing kinematic marker used to measure in the study (48)

CHAPTER 3
METHODOLOGY

Research Design

This research is a cross-sectional design study.

Participants

Thirty six adults in working age of 18-59 years old (Male = 5 Female = 31) who gain an experience of working with prolonged sitting, more than 6 hours per day and longer than 12 months with normal BMI (3) was recruited in this study. Additional inclusion criteria was felt pain at lower back VAS is 0-3 with tolerable to handle by self-resting and no need pain resolution as visit medical staff, take pain killer or pain therapy. Participant who met the eligibility criteria was recruited into the current study.

Exclusion criteria was BMI over 25 kg/m^2 or less than 18.0 kg/m^2. Participants with moderated pain indications at the time of study, on medication or pain therapy 2 weeks prior to the study, or had a neurological disease such as a stroke, spinal cord injury, multiple sclerosis etc. were excluded. In addition, participants with a history of any orthopedic surgery at the spine and pelvic regions or had spinal idiopathic disorder as idiopathic scoliosis, diffuse idiopathic hyperostosis was also be excluded.

Participants had the right to withdraw their consent to take part in the study at any time in regard to their own safety. The researcher was applied any physiotherapy treatment (Ultrasound therapy, superficial heat, gentle massage or stretching, etc.) to the participants who had pain intensifying throughout the study to help to alleviate any stress or discomfort.

Sampling the sample size

The participants were recruited by using a purposive sampling method to reach the target population. The sample size was calculated by using a G-power program. The effect size from the similar research design, procedure and same outcome measurement was used in the study and will investigate 3 parameters, including perceive pain intensity from Curran et al, 2014 (32), lumbar lordotic curve from Grodin et al, 2013 (15) and pelvic tilting angles from O'keeffe et al, 2013 (31).

Therefore, number of sample size of the current study was 36. By using Curran et al's study as a reference with effect size = 0.545 and 95% confidence interval (32). However, in case of participant withdrawal or cannot continue the research process for each participant. The additional participants were recruited to complete the aiming of sample size.

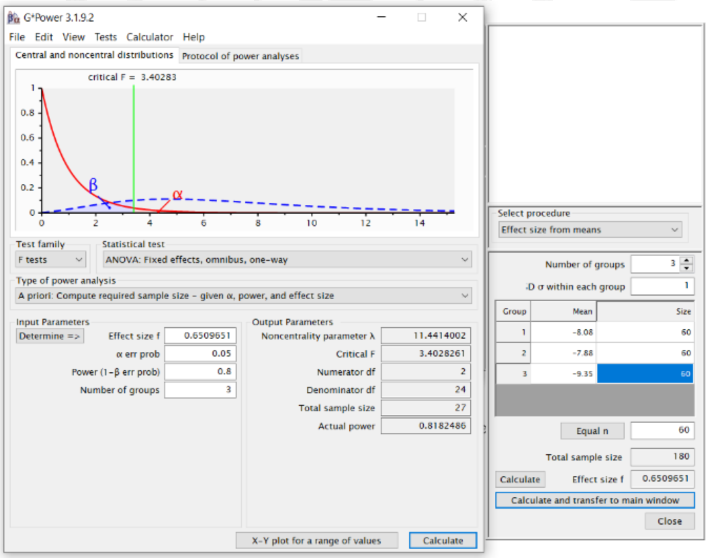

Figure 12 Effect size and total sample size calculated from data of pelvic tilting degrees mean between sitting posture (31).

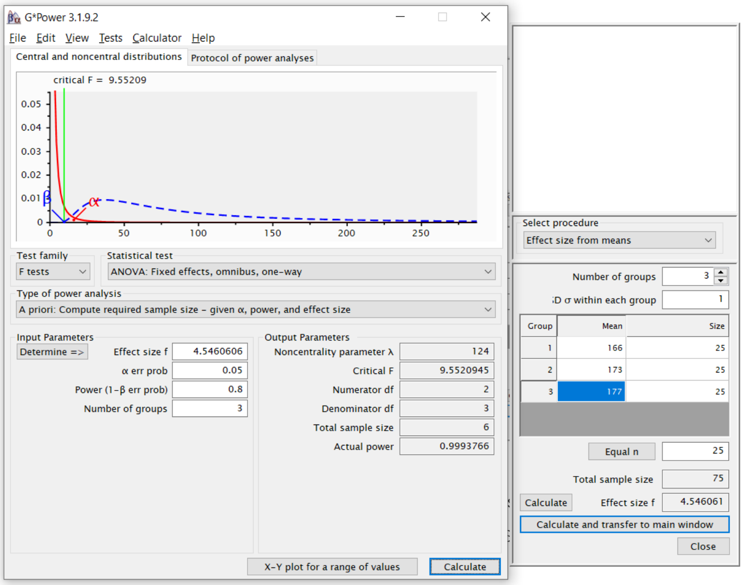

Figure 13 Effect size and total sample size calculated from data of lumbar lordosis degrees mean between sitting posture (15).

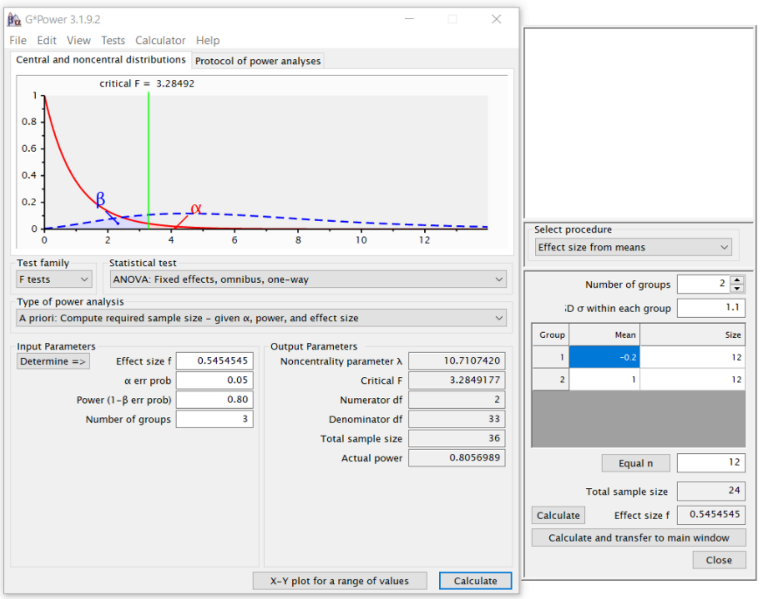

Figure 14 Effect size and total sample size calculated from data of discomfort scale mean between difference seat inclination (32).

Setting

Faculty of Physical Therapy, Srinakharinwirot University (Ongkharak), Thailand

Variable of study

Independent variable

Sitting with no cushion on a standard chair with doing a computer task on ergonomic desk

Sitting with pelvic seat cushion on a standard chair with doing a computer task on ergonomic desk

Sitting with lumbo-pelvic seat cushion on a standard chair with doing a computer task on ergonomic desk

Dependence variable

Thoracic angle

Lumbar angle

Pelvic angle

Perceived pain intensity

Location of pain

Research Instrument

Innovative seat cushion design

There were 5 steps in the innovative seat cushion designing process.

Step 1: Reviewed previous studies to determine design parameter

Before designing seat cushion, it must be determined design parameters to induce upright sitting posture. The previous studies could conclude that as below.

It is apparent that an anterior pelvic tilting angle reduces in sitting posture, caused by a biomechanical spinal pattern. However, a lot of reduction of the pelvic tilt could lead to poor posture. The design of the cushion has to correct and maintain the pelvic tilt angle. Erect sitting in healthy group showed 3.1 degrees of anterior pelvic tilting and 4.4 degrees of lumbar angle. Ten degrees of wedge shape seat pan on chair with back seat promoted lumbar angle (30). Ten degrees forward seat pan slope with on back seat induced anterior pelvic tilt and lumbar lordotic curve (31). This slope angle was used as reference of seat cushion design in this study as 1st design parameter (DP).

A previous study found peak pressure was around a quarter of the length from the back of the chair seat pan while in a relaxed sitting posture (50, 51) (Figure12). It is probable as this area has the most contact with the buttocks. Therefore, this area could build an effective counter force to tilt the pelvic area forward while sitting on the chair. Meanwhile, with the 10 degrees tilting forward of the seat pan, it has height between hypothetical parallel line and the seat pan at peak pressure area. This height can calculate, via a trigonometry formula, this height of peak pressure area value was used for reference as a part of this cushion design. So that the depth of pelvic seat cushion is considered as 2nd DP. The height of pelvic seat cushion at peak pressure area is considered as 3rd DP.

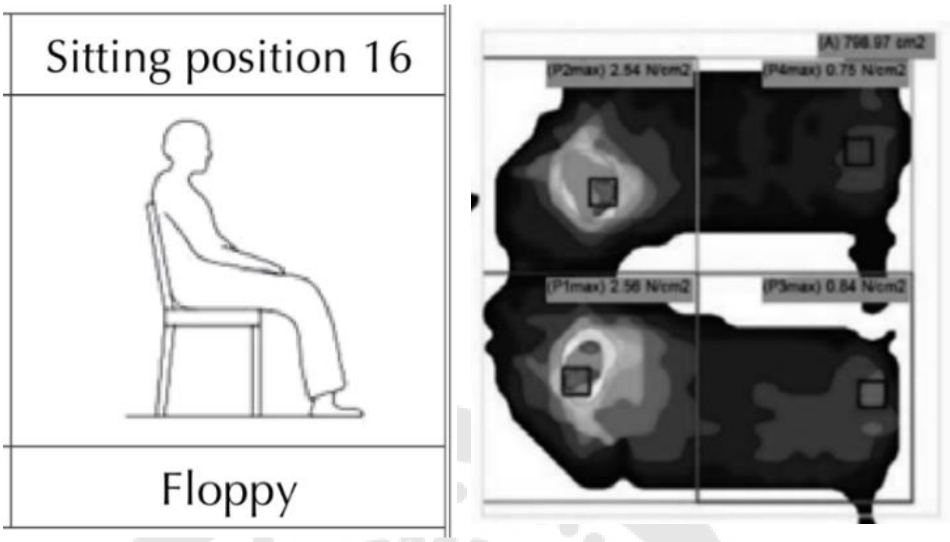

Figure 15 Pressure distribution of ‘Floppy’ sitting position (50)

The height of the seat cushion is also an important factor. A previous study found that the posterior of the peak pressure area of the seat while sitting showed less contact area. Increasing the height of the cushion at the posterior area, which produces more contact area, probably can promote anterior pelvic tilt. This height was referenced from the average value of the thigh clearance in the anthropometry of Thai people (52). From the previous study above the posterior height of pelvic seat cushion was considered as 4^{th} DP. To stabilize lumbar angle must be used the proper angle of cushion to fix the human lower back in the right position. This angle was calculated by using triangular formulas and the variable value from normal human pelvic anterior tilting angle while sitting. This angle was considered as 5^{th} DP.

Step 2: Reviewed exist seat cushion design

Current cushion designs which are available on market were designed to stimulate anterior part of the seat cushion to induce anterior pelvic tilting. However, wedge design have low height of inclination and no consideration of pelvic support (33) which is posterior part of cushion to maintain good pelvic and lumbar angles. The posterior height dimension of seat cushion from previous study or from exist designs were not height match to 4th DP which probably cannot produce enough contact area to promote anterior pelvic tilt as prediction of this study. Afterward 2 existed designs which the best seller seat cushion design in 2018 at Amazon.com were chosen to compare and evaluate new seat cushion design in next step.

Step 3: Design seat cushion with design parameter

The prototype seat cushions were designing used all of design parameters which referenced on previous studies as abovementioned. The 1st of seat cushion design was contained 1st DP design parameter to create design to determine the effect of slope surface only. The 2nd of seat cushion design was contained 1-5 design parameters to create the seat cushion design to added probably effect from other parameters expectation. The curvature was applied to the surface of 2nd cushion design, to refute a previous study, and it could reduce the effect of the changed in slope caused by the size reduction. This curvature was not referenced previously, so using another value from the design was to be calculated by AutoCAD plant 3D software and became the various.

1st seat cushion concept design

1st DP is the slope degrees

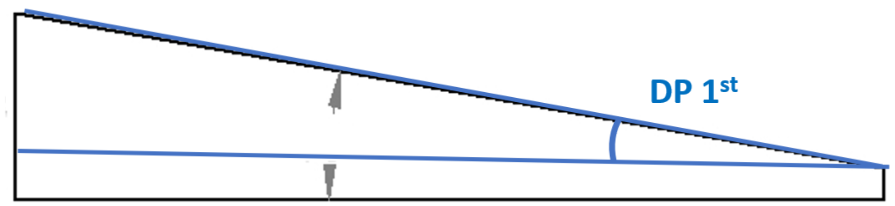

Figure 16 Design parameter of pelvic seat cushion concept design

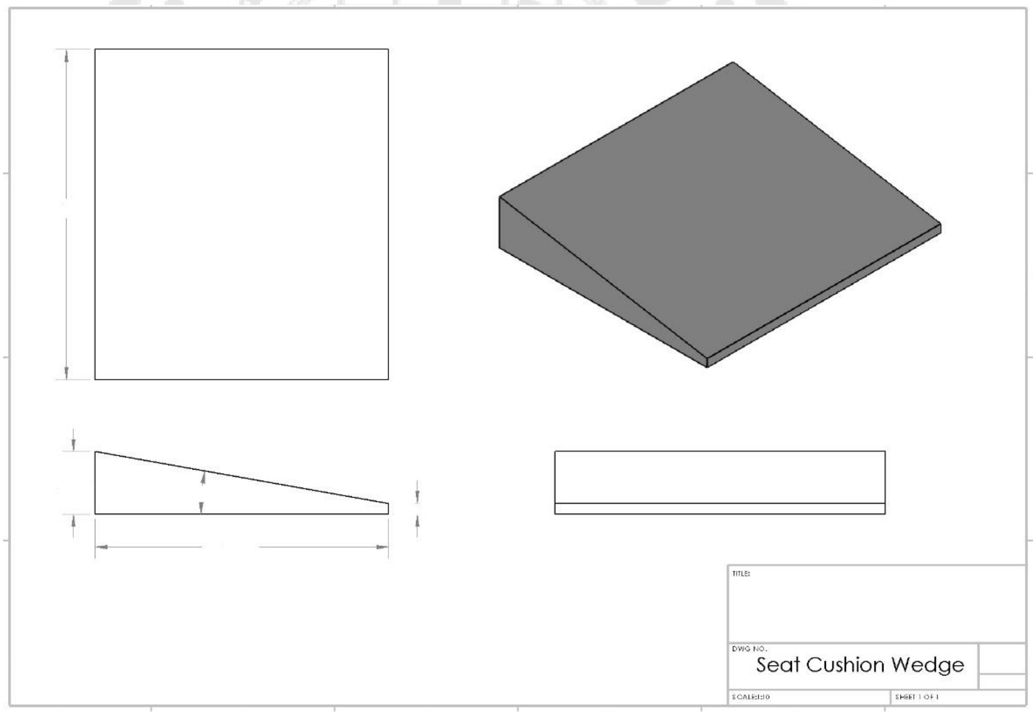

Figure 17 Lumbar seat cushion design blueprint

2nd seat cushion concept design

1st DP is the slope degrees

2nd DP is the depth to peak pressure area of seat cushion

3rd DP is the height of seat cushion at peak pressure area

4th DP is the posterior height of seat cushion

5th DP is the angle of cushion posterior part

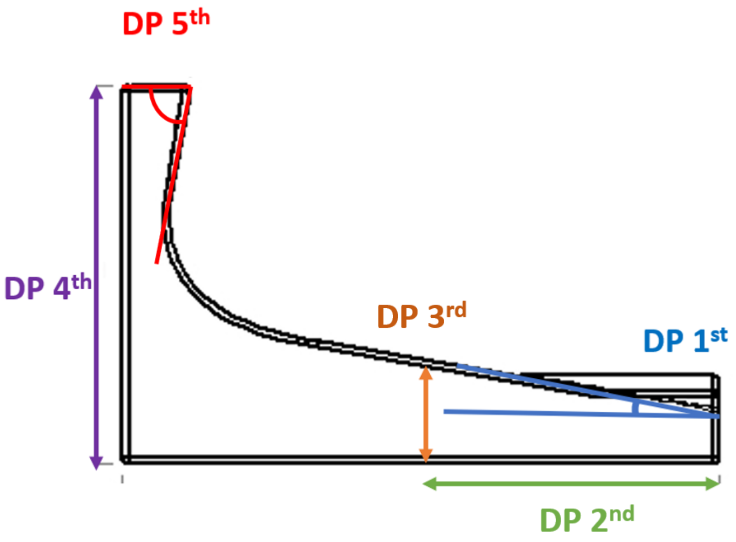

Figure 18 Design parameter of pelvic seat cushion concept design

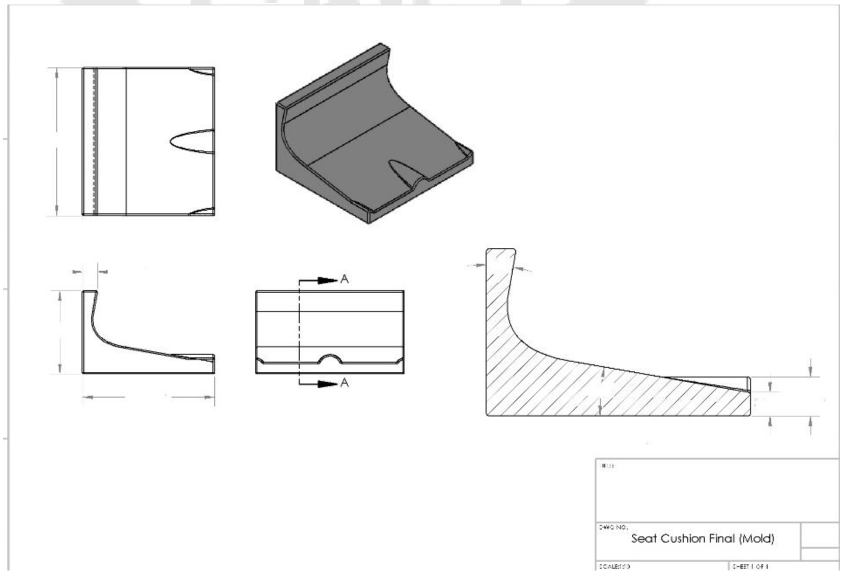

Figure 19 Lumbo-pelvic seat cushion design blueprint

Step 4: Seat cushion design evaluation

Pugh matrix was used to evaluated new Lumbo-pelvic seat cushion design in this study. The calculation process of Pugh matrix was already explained in review literature part, the criteria of Pugh matrix was defined clearly and identification as table below.

Table 1 Identification for each criterion in Pugh matrix used

Criteria	'same' level identification	'better' level identification	'worst' level identification
Criteria 1: Probably effectiveness of lumbo-pelvic posture maintenance	The design' cushion can maintain or promote lumbar and pelvic tilting angle but no longer than 10 minute or can promote angles but not significantly change into ideal correct sitting posture	The design' cushion can promote lumbar and pelvic tilting and maintenance angles more than 10 minutes	The design' cushion cannot maintain or promote any angles or reduce angles into poor sitting posture as slouch and slump posture
Criteria 2: The design is containing critic design parameter	The design' cushion has contained design parameter but not all	The design' cushion has contained all design parameter	The design' cushion doesn't have or match with design parameter
Criteria 3: Easy to move as portable item	The design' cushion Considered as can move out from chair but look feel hard to carry out with user	The design' cushion considered as can move out from chair and easy to carry out with user	The design' cushion considered as hard to move out from the chair

Table 1 (Continued)

Criteria 4: Easy to use by user	The design' cushion considered as every user can use but feel hard to adjusted correctly	The design' cushion considered as everyone can easy to be adjusted on chair and used correctly	The design' cushion considered as it looks hard to be adjusted on chair and used correctly by every user
Criteria 5: Estimated cost for manufacturing protocol	The mold and proceeding cost are nearly or as same as other commercial design	The mold and proceeding cost are cheaper than other commercial design	The mold and proceeding cost are higher than commercial design
Criteria 6: Manufacturing complexity	The prototype must be adjusted by handcraft or robotic protocol after mold forming	The proceeding of manufacturing with archetype mold can be done without any adjustment after mold forming	The prototype must be a lot of adjusted by handcraft or robotic protocol after mold forming

Pugh Matrix was weighted, scored and commended by 3 experts, who are specialist in related fields (Including ergonomic, industry manufacturing and biomechanical). Three specialists discussed in agreement to draw the conclusion scoring. The result of total score in Pugh matrix was compared among 2 exist seat cushion and Lumbo-pelvic seat cushion was summarized in table 2

Table 2 Pugh matrix scored by 3 specialists

	Weight			Lumbo-pelvic cushion design
Criteria 1:	3	S	-	++
Criteria 2:	2	S	-	++
Criteria 3:	2	S	S	S
Criteria 4:	1	S	S	S
Criteria 5:	1	S	S	S
Criteria 6:	1	S	S	S
Total +		0	0	+10
Total -		0	-5	0
Total score		0	-5	+10

The total score of Lumbo-pelvic cushion design was higher than both exist seat cushion design. Afterward, the Lumbo-pelvic cushion design was finalized and refined after adjustment due to conclude the opinion of specialists.

The pelvic cushion design was not included into Pugh matrix method because the pelvic cushion design was designed based on an exist ergonomic seat pan design which probably induced upright sitting posture.

Step 5: Prototype preparation

Latex intensity formulas and value of measurement unit in blueprint was use to calculated to compensate the collapse of seat cushion while participant sits on the cushion to maintain the design parameters of seat cushion. 3D prototype blueprints were used to generate and optimize to cutting tool via cutting program. The cutting operation was simulated in software, showing any error or potential tool collisions. The steel block was cut via collet followed programmed software into mole of seat cushion shape. Heated latex was injected in assemble mole after scrap cleaning. Afterward, cooldown the latex to solidify, take it out from mole and remove the surplus latex. The innovative seat cushion was developed completely.

Desktop computer Workstation

To eliminate the confounding factors that may disturb sitting posture in this study, the ergonomic computer workstation was determined by ergonomic correction. This study's workstation was arranged and addressed from the OSHA checklist as to protect the effect of the confounding factors of workstation dimensions, monitor and input device placements.

For the office chair, in order to prevent seat inclination, the chair will be positioned as standard, with a flat seat pan. Office chair is an adjustable height of seat to be suitable for various height of office worker participant.

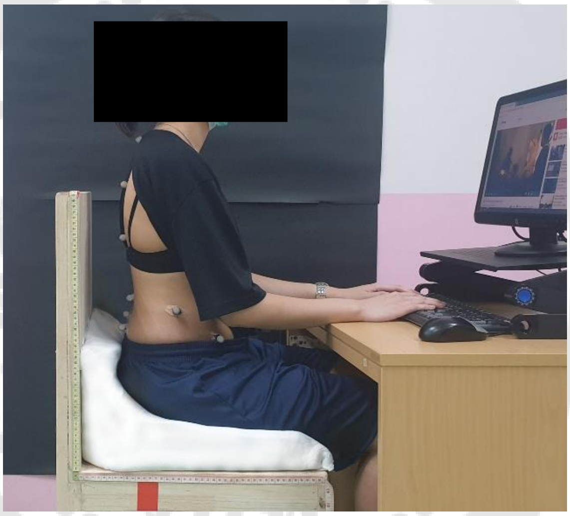

Figure 20 Participant sat on standard chair with Lumbo-pelvic seat cushion working on computer under OSHA workstation ergonomic guideline adjustment.

The computer set which consist of 17 inches Viewsonic VA702 adjustable angle screen monitor (V/A 1280 x 1024/16:9/75Hz), HP Pavilion a6375d Home PC workstation (Intel Pentium Duo-Core Processor E2200 3.1 GHz /L2 Cache 1024MB DDR2 RAM 2 GB/ HDD 250 GB-DVD-ROM Drive), Logitech MK220 wireless mouse and keyboard set. The PC workstation was contained and operated on Windows 10 Home edition with licensed 365 MS office/Standard web browser and Standard chatting programs.

Lumbar and Pelvic angles Measurement

To record the angle in sitting posture, a 2-D Nikon D5300 Camera (HDR 2K resolution 30 FPS 13.5 M-Pixel) will be used. The camera was placed perpendicular to the floor on the right side and 3 meters far from the workstation. Seven spheres contract-colored markers with the diameter of 15 millimeters was be attached at the bony prominence of spinous process of T1, T5, T10, L3, S2, Tip of iliac crest, ASIS and PSIS. A camera will be used to capture the video of the participants, perpendicular to the sagittal plane view; 5 seconds at 0 and 10 minutes. The time was be conducted with a calibrate standard stopwatch.

Kinovea program was be used to create vectors and angles from captured videos via the imported video session and was arrange the vector into the marker position. Subsequently, we were find the intersection point to define the angles by using the program's tools. The investigator must have an excellent intra-rater reliability (ICC > 0.75). The validity tests confirmed that the obtained results are acceptable for all perspectives, with a correlation value of 1 (ICC = 1) recorded for all three observers (47).

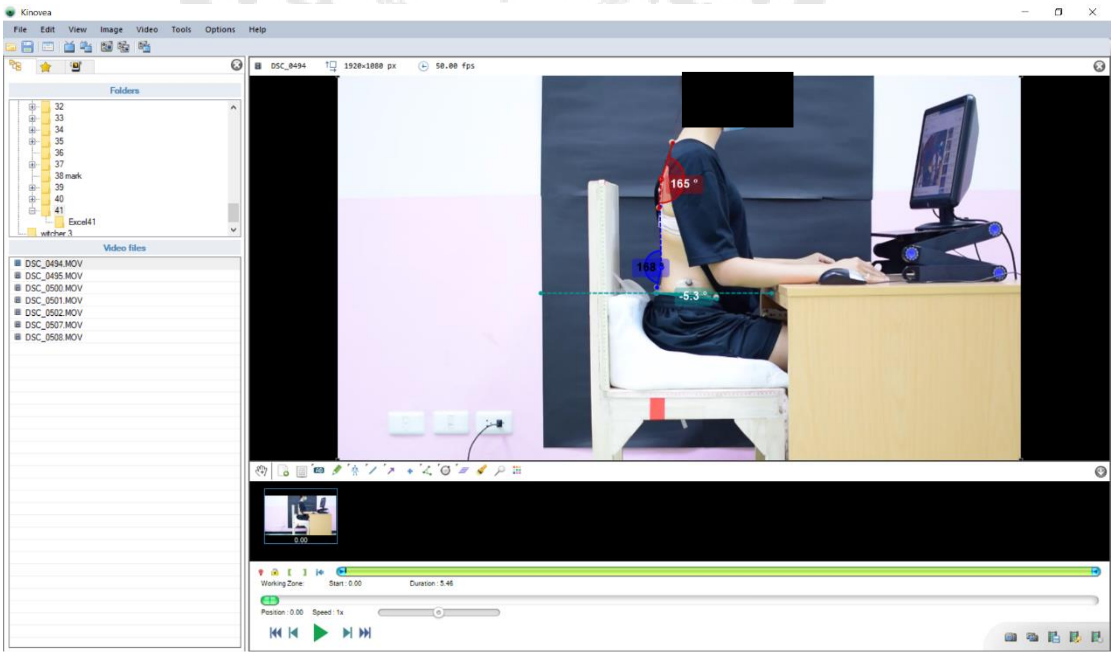

Figure 21 Kinovea program desktop

The placement of the markers was at the spinous process at T1, defined as upper apex of thoracic kyphosis curve area, T5, defined as apex of thoracic kyphosis convex area, T10 defined as the lower apex of the lower thoracic kyphosis curve and upper apex of lumbar lordotic curve area, L3 defined as the apex of the lumbar lordotic convex area. And S2 defined as the lower apex of the lumbar lordotic area. The right PSIS, defined as the primary changeable landmark of anterior/posterior pelvic tilting and, the ASIS defined as the secondary changeable landmark of anterior/posterior pelvic tilting.

Reliability of Angles Measurement

Before data collection, Intra-rater reliability of investigator in process of using Kinovea program. Four participant which was 10 percent of sample size calculation was recruited into this process All markers were attached on bony prominent by an assessor. Attachment of marker was checked the placement correctly by an expert in Musculoskeletal Physical Therapy. The sitting with no cushion on standard chair was captured by Nikon D5300 for 5 seconds. Afterward, Each angle was processed via Kinovea program twice on two separated days with at least a 24-hours lapse between sessions of repeated measuring for each angle (53). Pelvic tilting, lumbar and thoracic angle was calculated. once.

Definition of Angle

Thoracic angle was defined by using 3 markers at T1, T5 and T10 spinous process level (48) by using T5 as an intersection point (Figure 22).

Lumbar angle was defined with the marker at T10, L3 and S2, as normal by using L3 as an intersection point (Figure 23).

Pelvic angle was defined as the angle from the ASIS and the PSIS and the hypothetical line. Substitute ASIS- PSIS vector, by using PSIS- Hypothecal line, and find the intersection point to define a new angle that can be used as the original degree. Please see figure 24.

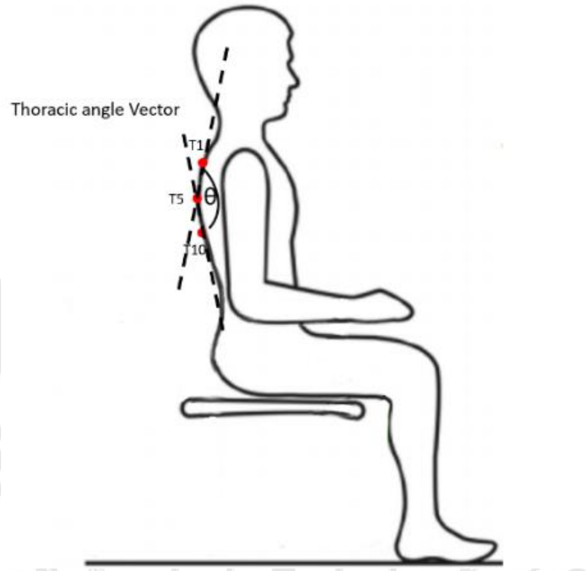

Figure 22 Show defines of thoracic angle

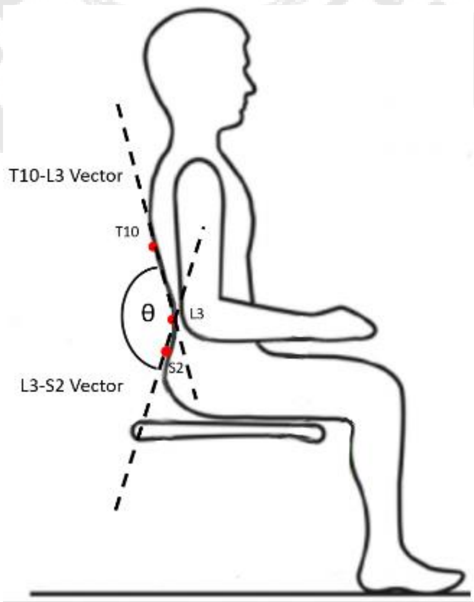

Figure 23 Show defines of Lumbar angle

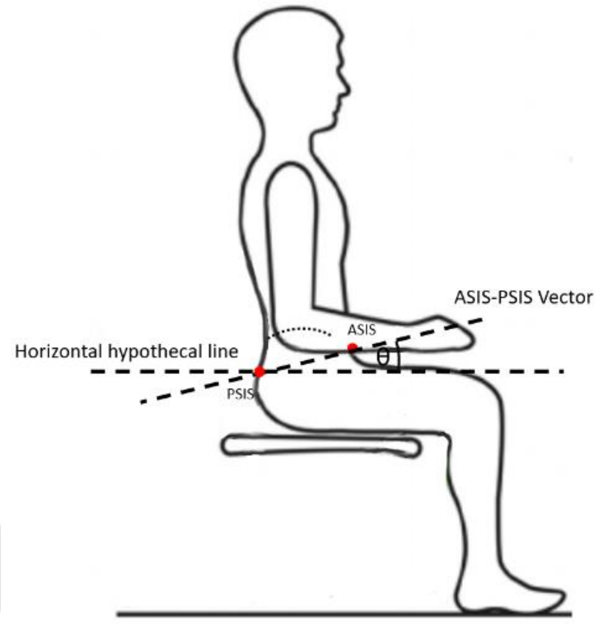

Figure 24 Show defines of Pelvic angle

Body Pain chart

For measuring pain, a modified body chart, only posterior body with VAS was used (54). The chart was modified and separated into body areas, comprising of 6 parts: posterior neck, shoulder, upper back (as the related area) and lower back, buttocks and thighs, all as the primary interested areas. The numeric rating pain scale for measuring pain intensity must be added on the scale next to the body chart in order to clarify the pain intensity of the participant in that particular body part. The pain severity frequency was scaled on a 100mm. horizontal row. The block row, starting from the left, shows no pain. The far right shows extremely strong pain. Ten minutes after starting the process, participants will be marking the line that indicates their level of pain in the block near the body chart (Figure 25).

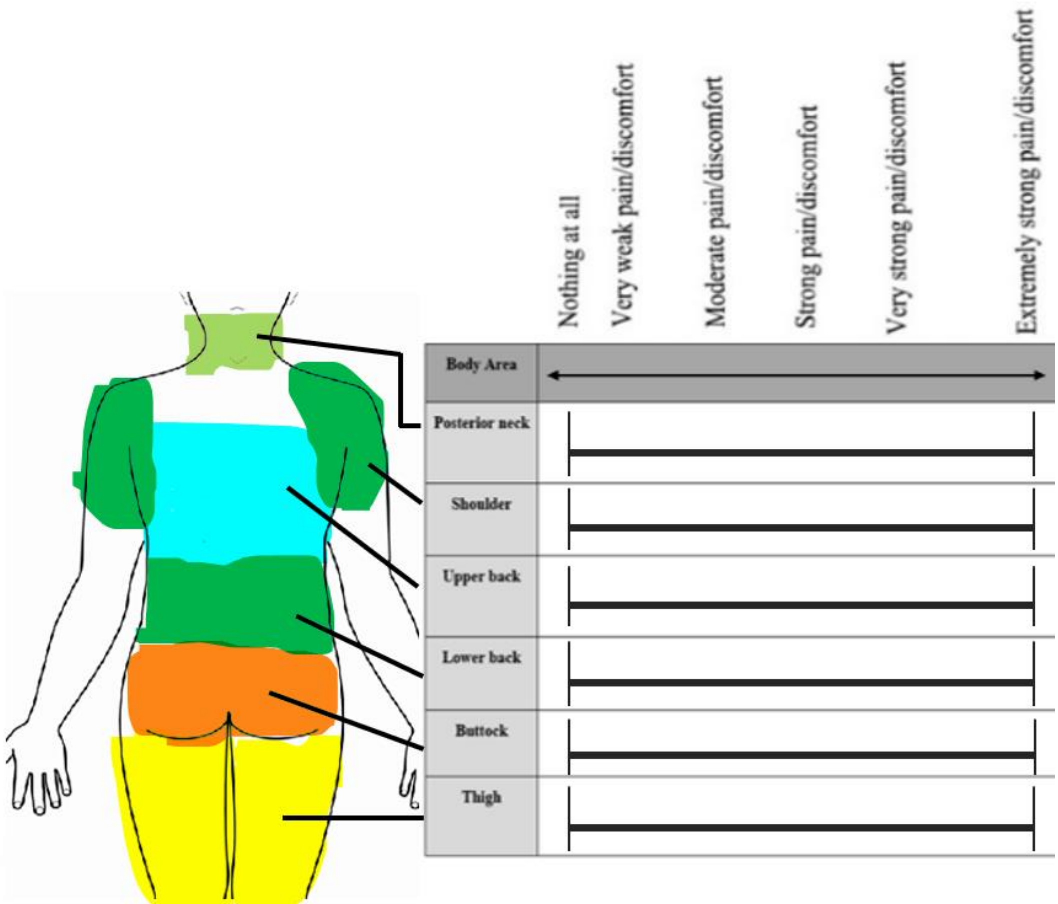

Figure 25 Modified body chart for pain scale

Procedure

Participants were screened by questionnaires and had weight and height measured for calculating their BMI. Participants that included were those that match their search criteria. After reading the agreement and consent form, all of the participants were signed, granting their consent. They were agreed to a random order of workstations, over 3 sessions, by using a randomized computer program. All participants were assigned as using a computer browser.

First session as 'Sitting on standard chair with doing a computer task on ergonomic desk', second session as 'Sitting on standard chair add on lumbar seat cushion with doing a computer task on ergonomic desk and third session as' Sitting on standard chair added lumbo-pelvic seat cushion with doing a computer task on ergonomic desk'. Participants were unaware of the order of the sitting sessions.

Prior to collecting the data, the system was calibrated perpendicular to the camera tripod on the floor and perpendicular to the chair sagittal diameter with the camera by using level tools and the camera range with a measuring tape.

Eight markers were attached on the body based on the bony prominence as Right ASIS, PSIS, Tips of Iliac crest, Spinous process at T1, T5, T10, L3 and S2 level by the investigator who completed the intra-rater agreement with excellent correlation (ICC = 0.9-1.0). Investigator gave the instruction as sitting straight without body rotation and typing follow the provided article. The Participants sat in provided ergonomic computer workstations and start the process. The camera was captured the right side of participant and the computer workstation. Each session's participants were worked on the computer in regulative work for 10 minutes. At 0 and 10 minutes, participants were asked to define had a 10 minute interval resting, to help release the effects of prolonged sitting in the position of side lying on provided bed with bolster to protect marker flaking off from participants skin, and was furthered continue the process of the other sitting conditions (55). Room temperature, lighting and noise were controlled to maintain a consistency in the environment throughout the study.

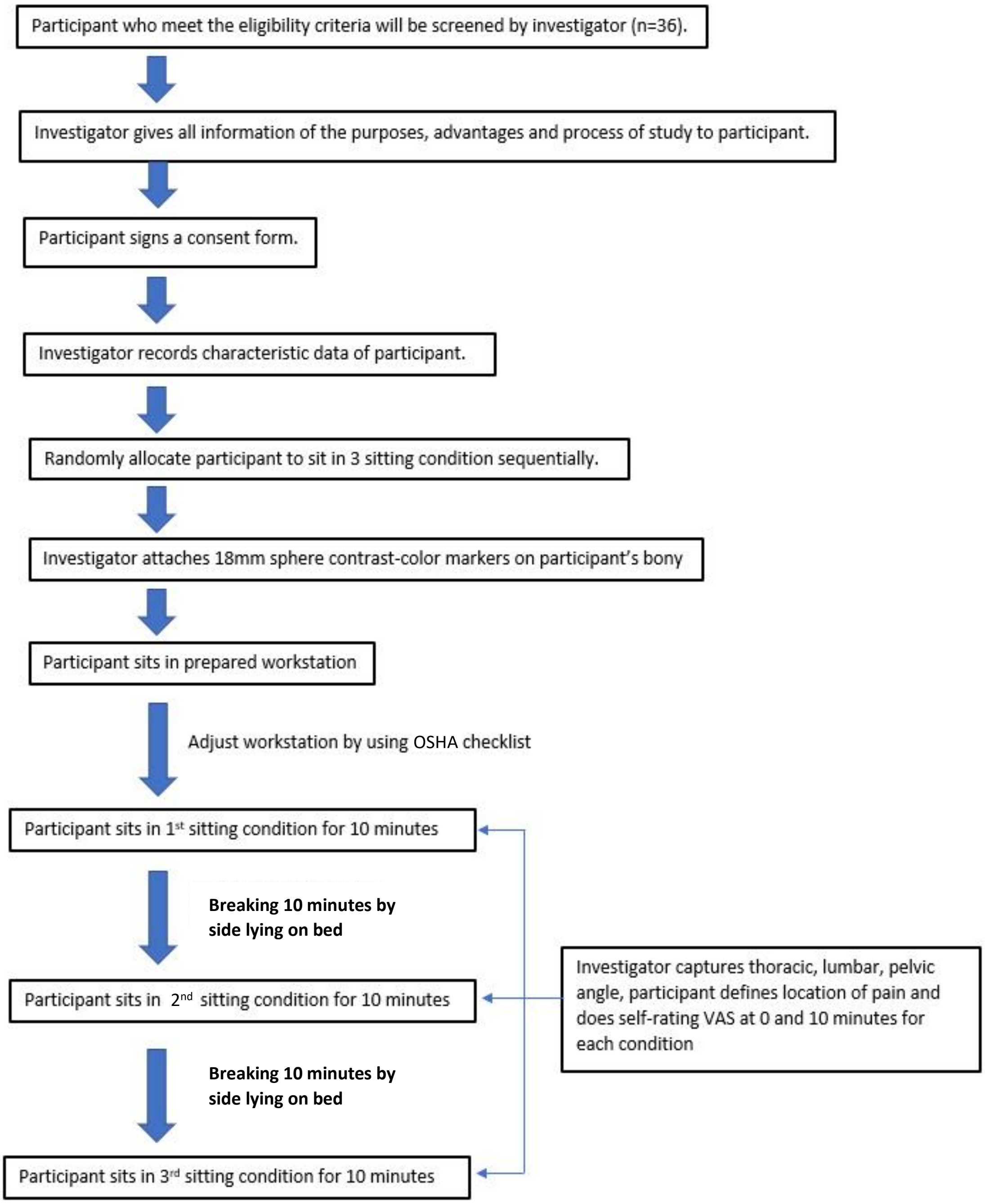

Figure 26 Procedure for this study

Statistical analysis

A histogram of data was plotted to analyze normal distribution of data and the Kolmogorov Smirnov test were used. One-way repeated ANOVA with Bonferroni post-hoc analysis was used to compared perceived pain intensity, thoracic, lumbar, and pelvic angles among 3 conditions. Pair T-test was used to compared thoracic, lumbar, and pelvic angles between 0 and 10 minutes sitting for each group. The significant difference was set at p-value < 0.05. Mean and standard deviation used to calculate the number of locations of pain, overall perceived pain intensity of region marked. All of statistical analyses in this study was analyzed by using SPSS program version 24.

CHAPTER 4
FINDING

Introduction

The results consist of intra-rater reliability of measurement, characteristics of participants, comparison of pelvic tilting, lumbar, and thoracic angles among 3 sitting conditions at 10 minutes, number of participant and percentile of pelvic tilting angle characteristic, comparison of perceived pain intensity after sitting for 10 minutes among 3 sitting conditions and comparison of difference value of perceived pain intensity between 0 and 10 minutes among 3 sitting conditions.

Intra-rater Reliability

The intra-rater reliability of measurements is summarized in table 3. The results demonstrated excellent reliability of pelvic tilting (ICC = 0.98), lumbar angle (ICC = 0.991) and thoracic angle (ICC = 0.998) measurement using Kinovea program with the ICC (3,1).

Table 3 Intra-rater reliability measurement.

	ICC (95%CI)	SEM (Degrees)
Pelvic tilting angle	0.987 (0.873-0.999)	0.56°
Lumbar angle	0.991 (0.907-0.999)	0.81°
Thoracic angle	0.998 (0.982 – 1.000)	0.54°

Characteristics of Participants

Thirty-six volunteers (31 females, 5 males) were recruited into this study. Mean ± standard deviation and range of age, weight, height, and BMI are summarized in Table 4 and the frequency of age group is summarized in Table 5 respectively.

Table 4 The demographic characteristics of participant (N=36)

Participant	Mean ±SD
Age (years)	32.6 ± 9.6
Height (cm)	160.1±8.7
Weight (kg)	54.4±9.2
BMI (kg/m^2)	21.1±2.2

Table 5 The Number of participants in each age groups

Age group (years old)	Number of participants
≤ 20	6
21-30	9
31-40	13
41-50	6
51-60	2

Comparison of pelvic tilting, lumbar, and thoracic angles among 3 sitting conditions at 10 minutes

The mean and standard deviation of pelvic tilting, lumbar, and thoracic angles at 10 minutes are summarized in Table 6. There was a significant difference of pelvic tilting angle between no cushion and Lumbo-pelvic cushion design (P-value = 0.01). Also, there was a significant difference of lumbar angle between no cushion and Lumbo-pelvic cushion design (P-value = 0.05). But there was no significant difference of pelvic and lumbar angle between no cushion and lumbar cushion design and, also there was no significant difference of pelvic angle between pelvic cushion design and Lumbo-pelvic cushion design. There was no significant difference of thoracic angle among no cushion, and pelvic cushion design, and Lumbo-pelvic cushion design.

Table 6 Comparison of pelvic, lumbar, and thoracic angles at 10 minutes among sitting condition

Parameter (Angle)	Sitting condition			F
	No cushion	pelvic cushion design	Lumbo-pelvic cushion design	
Pelvic tilting	3.5°±6.2°[a]	1.0°±5.5°	-1.3°±5.6° [a]	6.12
Lumbar	176.3°±8.3°[b]	173.1°±8.9°	171.4°±8.2° [b]	3.03
Thoracic	163.9°±6.3°	165.0°±6.2°	163.9°±5.7°	0.41

Minus value of pelvic angle = anterior pelvic tilting, one-way ANOVA at p-value < 0.05, [a] sig dif between No cushion and Lumbo-pelvic cushion design (P-value < 0.01), [b] sig dif between No cushion and pelvic cushion design (P-value = 0.05)

Number of participant and percentile of pelvic tilting angle characteristic

The characteristic of pelvic tilting angle was defined into 4 groups; Posterior tilting more than 3°, Posterior tilting at 0° to 3°, Anterior tilting at 0° to 10°and Anterior tilting more than 10°.The frequency and percentile of pelvic tilting angle characteristic of each sitting condition are summarized in Table 7. Number of participant (n=19) in no cushion showed posterior pelvic tilting more than 3 degrees whereas number of participant (n=8) in Lumbo-pelvic cushion showed posterior pelvic tilting. Number of participant (n=13) in no cushion showed anterior pelvic tilting 3 - 10 degrees whereas number of participant (n=18) in Lumbo-pelvic cushion showed anterior pelvic tilting.

Table 7 The frequency and percentile of pelvic tilting angle characteristic

Parameter (Angle)	Sitting Condition					
	No cushion		Pelvic cushion design		Lumbo-pelvic cushion design	
	Frequency (n)	Percent (%)	Frequency (n)	Percent (%)	Frequency (n)	Percent (%)
Posterior tilting >3°	19	52.8	13	36.1	8	22.2
Posterior tilting 0°-3°	4	11.1	9	25	10	27.8
Anterior tilting 0°-10°	13	36.1	14	38.9	16	44.4
Anterior tilting >10°	0	0	0	0	2	5.6
Total	36	100.0	36	100.0	36	100.0

Comparison of pelvic tilting, lumbar, and thoracic angles between 0 and 10 minutes of in 3 sitting conditions

The means and standard deviation of angle of pelvic tilting, lumbar and thoracic angles at 0 and 10 minutes are summarized in Table 8. There was no significant difference of pelvic tilting, lumbar and thoracic angle between 0 and 10 minutes sitting in all sitting conditions.

Table 8 Comparison of pelvic tilting, lumbar, and thoracic angles between sitting at 0 and 10 minutes among sitting condition.

Parameters	Sitting conditions	0 minute	10 minutes
Pelvic tilting angle	No-cushion	4.2°±5.6°	3.5°±6.2°
	pelvic cushion design	-0.1°±5.3°	1.0°±5.5°
	Lumbo-pelvic cushion design	-1.4°±4.9°	-1.3°±5.6°
Lumbar angle	No-cushion	176.2°±8.6°	176.3°±8.3°
	pelvic cushion design	171. °4±7.2°	173.1°±8.9°
	Lumbo-pelvic cushion design	169.9°±8.3°	171.4°±8.2°
Thoracic Angle	No-cushion	163.7°±5.2°	163.9°±6.3°
	pelvic cushion design	163.9°±6.3°	165.0°±6.2°
	Lumbo-pelvic cushion design	163.8°±5.4°	163.9°±5.7°

Comparison of perceived pain intensity after sitting for 10 minutes among 3 sitting conditions

The mean and standard deviation of perceived pain intensity at 10 minutes are summarized in Table 9. There was significant difference of perceived pain intensity at the lower back area between no cushion and Lumbo-pelvic cushion design (P-value = 0.04). In addition, there was significant difference of perceived pain intensity at the lower back area between no cushion and pelvic cushion design (P-value = 0.03). However, there was no significant difference of perceived pain intensity in posterior neck, shoulder, upper back, buttocks and thigh among three cushions.

Table 9 Comparison of perceives pain intensity after sitting for 10 minutes on a chair in each sitting condition

Body areas (Total score = 100)	Sitting condition			
	No-cushion	Pelvic cushion design	Lumbo-pelvic cushion design	F
Posterior neck	2.3±6.8	1.6±5.8	1.4±5.4	0.23
Shoulder	0.1±0.9	0.8±2.5	0.9±4.1	0.81
Upper back	1.6±6.4	0.6±0.3	0.5±2.5	1.34
Lower back	4.6±9.5[a,b]	0.9±3.1[b]	1.1±2.7[a]	4.37
Buttock	2.4±7.2	0.8±3.3	0.3±1.2	2.23
Thigh	2.0±6.6	0.8±3.4	0.5±2.0	1.13

[a] sig dif between No cushion and Lumbo-pelvic cushion design (P-value < 0.05), [b] sig dif between No cushion and pelvic cushion design (P-value = 0.05)

Comparison of different values of perceived pain intensity between 0 and 10 minutes among 3 sitting conditions

Different values of perceived pain intensity between 0 and 10 minutes among 3 sitting conditions is shown in Figure 27. There was a significant increasing of perceived pain intensity during sitting from 0 to 10 minutes in each sitting conditions. The perceived pain intensity at the lower back in no cushion was increased significantly higher than in Lumbo-pelvic cushion design and pelvic cushion design after sitting for 10 minutes (P-value = 0.04, P-value= 0.02). There was no significant increasing of perceived pain intensity among 3 sitting conditions at posterior neck, shoulder, upper back, buttocks and thigh areas.

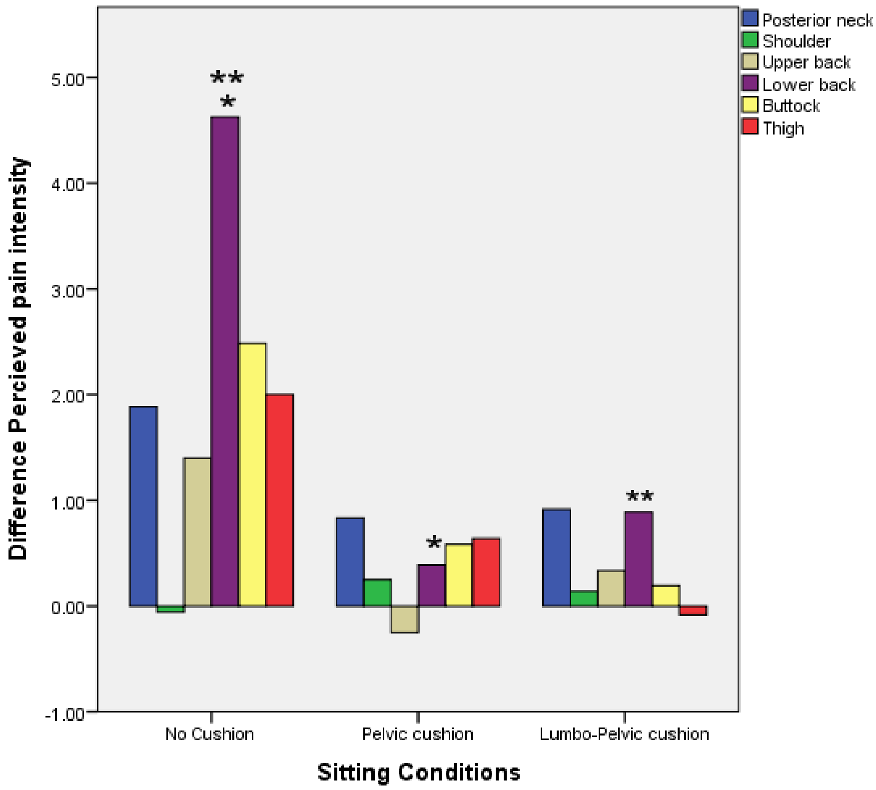

Figure 27 Different value of perceived pain intensity after sitting for 10 mins among 3 sitting conditions, *sig dif between no cushion and pelvic cushion design (p-value = 0.04), ** sig dif between no cushion and Lumbo-pelvic cushion design (p-value =0.02)

CHAPTER 5
DISCUSSION AND CONCLUSION

Introduction

This research studied the innovative prototype of the lumbo-pelvic seat cushion designed to prevent back pain by promoting and maintaining anterior pelvic tilting and lumbar angles. The lumbo-pelvic cushion was designed based on anatomy and ergonomics of the body, particularly pelvic and lumbar areas. Moreover, the formular and the response of the latex material to the weight of the participant supported and maintained alignment of the pelvic and lumbar areas with added comfort for office workers in sitting positions over long durations, particularly during a typical working day.

Participant

This study recruited the wide range age group of office workers. Previous studies found that disc degeneration is a spinal disease that found in age over 50 years (56). This study recruited only 2 participants over 50 years old. The difference of sitting posture and wide standard deviation which represent in this study probably cause by spinal degenerative disease in over 50 years old population. However, this study was studied the changing of interested angle with-in subject to reduce the effect of difference between age group factors. Meanwhile, this study also used the purposive sampling recruitment method to dispersion the participant into each age groups as summarized in table 5. However, number of some age group was still lesser than other. The Purposive sampling with a large number of participants in each age group should be considered for further studies to see the difference changing of interested angle in each age group population.

The previous study found that there was no significant difference in thoracolumbar angle and lumbar lordosis between gender while sitting on upright sitting posture (9). This study recruited 31 females and 5 males. However, sitting in preferred position was found that difference of pelvic and spinal alignment between two genders, therefore, the recruitment in same number of two genders is recommend in further study.

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Pelvic tilting, Lumbar and Thoracic angles

Comparison of pelvic tilting, lumbar, and thoracic angles among 3 sitting conditions at 10 minutes

The result of this study showed that anterior pelvic tilting angle in Lumbo-pelvic cushion design (-1.3°$\pm$5.6°) was significantly (P-value = 0.01) more than in the no cushion (3.5°$\pm$6.2°) after sitting for 10 minutes (Table 6). Anterior pelvic tilting angle in this study was related to the previous study of Yu et al, 2015 which found that anterior pelvic tilting angle in upright sitting were about 3° (13).

Result of this study clearly showed that the Lumbo-pelvic cushion design improved anterior pelvic tilting significantly more than sitting with no cushion. The result was related to a previous study which found that seat pan with 10 degrees of inclination improved anterior pelvic tilting and encouraged sitting upright position compared to no seat pain tilting (57). The angle of innovative Lumbo-pelvic cushion design is related to another previous study where tilting the angle of the seat pan helped to tilt the pelvic angle and increased lumbar lordosis which bears the same meaning as reducing lumbar flexion at approximately 10 degrees (58). Lumbo-pelvic design cushion was developed with a suitable curve and height of the cushion to improve anterior pelvic tilting while sitting, increase contact area at posterior part of the buttocks, and probably improve pressure distribution and counter-reaction force of the posterior part of the buttock area which is contacting the area to stimulate pelvic tilting forwardly. However, this study did not investigate the pressure distribution of buttock while sitting on seat cushion. Thus, it cannot be identified the characteristic of pressure distribution in each sitting condition. The difference of pressure distribution in each sitting condition should evaluated to prove the pressure distribution improvement in lumbo-pelvic seat cushion and pelvic cushion design in further study. In contrast, a previous study found that there was no change on the pelvic tilting angle during sitting on a wedged shape cushion, however the study conveys that the participants potentially had poor hip flexibility. To sum up, the pelvic area did not tilt (30). The pelvic tilting angle in this study was varied. Similarly, previous studies reported that large variations in sitting postures showed differences of pelvic tilting and lumbar angles which was attributed to the heterogeneity of spinal posture in healthy individuals (59, 60). In this study, the pelvic area tilted anteriorly at 1.3°±5.6°. Lumbo-pelvic cushion design helped to aid in anterior pelvic tilting; this angle did not reach 10 degrees as expected. Latex is an effective material for supporting body weight while sitting because of its sagging property. Nevertheless, latex density in each formular should be considered. Even though the sagging properties help aid comfort, the latex rubber used in this study had various formular on each company patent. Regardless of this, the lumbo-pelvic cushion design still induced a pelvic tilting angle in sitting posture in office workers.

The lumbar angle in Lumbo-pelvic cushion design (171.4°±8.2°) was significantly improved compared to no cushion (176.3°±8.3°, P-value = 0.05). However, there was no significant difference between pelvic cushion (173.1°±8.9°) and no cushion (Table 6). In term of biomechanics, the reduction of lumbar flexion in this study means the increasing of lumbar curve or lordosis. The results of this study related to previous studies which found that lumbar angle in healthy groups during erect sitting was 4 degrees (176 degrees in reverse direction) (13). In addition, the result of the current study was related to Kim et al, 2014 study which found that sitting on a wedged shape cushion of 10 degrees tilting significantly increased lumbar lordosis curve by 5 degrees (30). Likewise, sitting on an inclining wedge shape of 10 degrees also significantly increased of lumbar angle by 3° (27).

This study found that increasing of anterior pelvic tilting and lumbar lordosis was related to previous studies. There was a strong correlation of pelvic tilting and lumbar lordosis in the same direction in the sitting posture (61) and also found that anterior pelvic tilting induced a significant increasing of lumbar extension while sitting in slumped and upright postures (P-value<0.01) (23, 62). Therefore, sitting on a chair with cushions with proper slopes can encourage a good kinematic chain of the spine and prompt upright sitting postures.

The thoracic angle did not show any significant difference among no cushion (163.9°±6.3°), pelvic cushion (165.0°±6.2°) and Lumbo-pelvic cushion

(163.9°±5.7°) designs after sitting for 10 minutes (Table 6). However, this study provided an ergonomically sound desktop workstation based on ergonomic guidelines of Occupational Safety and Health Administration (OSHA) which encouraged a thoracic upright posture and normal posture alignment. It is widely suggested that proper computer adjustment stimulates upright sitting posture(14, 58). In OSHA guidelines, the computer screen is adjusted to a proper position with eye level and keyboard placed with elbow flexion at 90 degrees, hands placed on the keyboard and arms relaxed beside body. Appropriate ergonomics and effective seat cushion designs help stimulate the thoracic spine into an upright alignment.

Frequency and percentile of pelvic tilting angle characteristic while at 10 minutes among sitting condition

This study found significant increasing of anterior pelvic tilting between lumbo-pelvic cushion design compared to no cushion. From a previous study, it was found that the pelvic tilting angle in upright sitting posture ranged from 3 degrees of posterior tilting to 10 degrees of anterior tilting.

The pelvic tilting angle characteristic had shown a reduction in participants who displayed posterior tilting over 3° after sitting on the Lumbo-pelvic sitting cushion design compared to sitting with no cushion from 52.8% to 22.2% (Table 7). This result showed that Lumbo-pelvic cushion design improved the pelvic tilting angle in more than half of the participants with posterior tilting angle over than 3°. This study found various sitting postures and individual body anthropometry in the participants. The probable cause is the lumbo-pelvic cushion design did not fit to their lower back or buttocks during sitting sessions, even though the lumbo-pelvic cushion was designed based on Asian anthropometry which lead to having no improvement of pelvic tilting angle into at least posterior tilting 3°

Comparison between pelvic tilting, lumbar and thoracic angles at 0 minute and 10 minutes in 3 sitting conditions

In terms of maintain of angles after sitting for 10 minutes, the result of this study showed that there was no significant difference of pelvic tilting, lumbar and thoracic angles between 0 minutes and 10 minutes in three sitting conditions which were no cushion, pelvic cushion, and lumbo-pelvic cushion (Table 8). However, lumbo-pelvic cushion still helped to maintain anterior pelvic tilting even through sitting for 10 minutes (-1.4°+4.9° at 0 min, -1.3°+5.6° at 10 minutes). Yet, no cushion showed posterior pelvic tilting and participants continued in this poor pelvic posture for 10 min (4.2°+5.6° at 0 minute, 3.5°+6.2° at 10 minutes). Studies for longer durations are recommended due to a previous study showing that reduction of lumbar lordosis and more posterior pelvic tilting after sitting for 10 minutes were found ($P<0.01$) (9). In addition, this study uncovered that after sitting for 10 minutes, lumbar and thoracic angles still maintained the same alignment (Table 8). Therefore, lumbo-pelvic cushion is an effective design to help people maintain a comfortable and upright posture after sitting for 10 minutes.

Measurement of Angles

In this study, Kinovea program was used to measure pelvic, lumbar and thoracic angles, where we found that the reliability of measurement was excellent (ICC > 0.987). In addition, standard errors measurement (SEM) of this study ranged between 0.54° and 0.81° (Table 3) which is comparable to a previous study which were ranged between 0.61° to 0.77° (63).

Perceived pain intensity

Comparison among 3 sitting conditions

Perceived pain intensity in the lower back area after sitting for 10 minutes on the pelvic cushion and Lumbo-pelvic cushions was significantly lower than in no cushion (P-value = 0.04) (Table 9). This is in relation to a previous study which reported that adjusting the seat pan with tilting forward reduced lower back discomfort intensity in the back pain group when compared to sitting on a flat seat pan chair (p-value = 0.00) (32) . In addition, corrected sitting posture by ergonomic adjustments of the seat and workstation helped to reduce pain at the lower back area (P-value = 0.01) (64). Interestingly, the results of this study showed that pain in mild level was reported in no cushion, but pelvic and lumbo-pelvic cushion design was no pain after sitting for 10 minutes. However, perceived pain intensity of all sitting conditions did not reach clinically significant differences (40) after sitting for 10 minutes. Therefore, evaluation in longer time of sitting posture is needed for further examination.

Perceived pain intensity in other areas which were posterior neck, shoulder, upper back, buttocks, and thigh after sitting for 10 minutes did not show any significant difference among three sitting conditions (Table 9). Perceived pain intensity in all conditions was in no pain level where the pain scale was less than 4 mm in total 100 mm. Thus, it can be considered as no pain (65). To explain further, this study had prepared an ergonomically sound computer workstation correlating to the OSHA guidelines. A previous study found that ergonomic adjustments to the workstation helped to reduce VAS at posterior neck and upper back areas from 19 mm to 7 mm (66). In addition, adjusting the workstation with an ergonomic adjustable chair significantly reduced on the overall body pain/discomfort scale (67). Similarly, an applied ergonomic workstation for computer users based on OSHA checklist helped to prevent incidents of pain at neck and shoulder areas (14).

Comparison between sitting times at 0 minutes and 10 minutes among each sitting condition

The difference of perceived pain intensity between 0 minutes and 10 minutes in no cushion (VAS = 4.5+9.5) was significantly higher than that of in pelvic design (VAS = 0.4+3.6) and lumbo-pelvic cushion design (VAS = 0.9+2.8) (Figure 27). The findings of this study found that pain increased after sitting with no cushion for 10 minutes related to a previous study reported that sitting for 40 minutes induced pain at neck, shoulder, upper back, lower back, wrist and buttocks areas (6). In addition, the result of this study differs from the previous study which found that pelvic and back rest cushions did not help to prevent pain (33). It could be explained that cushion designs in previous studies did not help to encourage good pelvic and lumbar alignment, therefore pain intensity still increased after sitting for 12 minutes

Clinical Implication

Sitting upright posture is recommend during working in front of a computer. Lumbo-pelvic cushion design induced anterior pelvic tilting and lumbar lordosis, which helps to maintain an upright position after sitting for 10 minutes. Moreover, perceived pain intensity after sitting on the lumbo-pelvic seat cushion showed no pain after sitting for 10 minutes, but mild pain was found in the no cushion sitting condition. Therefore, we would recommend office workers to use lumbo-pelvic seat cushion designs to encourage good posture and prevent musculoskeletal pain.

Limitations and further studies

This study evaluated angles and description of pain in a healthy group for 10 minutes sitting, therefore these parameters should be evaluated in longer duration. In addition, previous studies found that office workers reported back and neck pain. Therefore, a back pain group should be included in evaluation of the product.

The design of the cushion is generally for all participants, which was calculated based on anatomy, ergonomics and results of previous studies. However, human anthropometry and sitting behaviors are varied, so further studies should consider a customized seat cushion design for individuals in their routine workstation.

The other limitation in this study is that participant did not have a fully back support cause of awareness of marker attachment. The fully back support at lumbar region could interrupt and slip the reflective markers. Therefore, this study used the other OSHA checklist to adjusted desktop computer workstation tom improve ergonomic correction which help to protect the other related workstation dimension confounding factors.

Large numbers of participants in each aged group should be considered for further studies to reduce wide standard deviation of angles cause by individual factors.

The equal number of participants in two genders should be considered to clear the suspicion of difference interested angle during upright sitting posture.

Conclusion

The pelvic seat cushion and lumbo-pelvic seat cushion design improved anterior pelvic tilting and lumbar lordosis angles when compared with no cushion in the healthy group. Lumbo-pelvic cushion design maintained anterior pelvic tilting, lumbar angles after sitting for 10 minutes. Perceived pain intensity at the lower back area after sitting on the pelvic and lumbo-pelvic cushion was no pain when compared with no cushion which found mild pain. Pain did not differ in the posterior neck, shoulder, upper back, buttocks, and thigh areas in 3 sitting conditions. We would recommend an office worker to apply a lumbo-pelvic seat cushion to prevent pain during working on a computer to promote good posture and prevent musculoskeletal pain.

REFERENCES

1. Thailand NSOo. สรุปผลที่สำคัญ: สำรวจการมีใช้เทคโนโลยีสารสนเทศและการสื่อสารในครัวเรือน พ.ศ. 2559. In: Thailand NSOo, editor. On website: National Statistical Office of Thailand; 2016. p. 51.

2. Daneshmandi H, Choobineh A, Ghaem H, Karimi M. Adverse Effects of Prolonged Sitting Behavior on the General Health of Office Workers. Journal of Lifestyle Medical. 2017;7(2):69-75.

3. Karoney MJ, Mburu SK, Ndegwa DW, Nyaichowa AG, Odera EB. Ergonomics in The Computer Workstation. East Afr Med J. 2010;87(9):382-5.

4. Gupta N, Christiansen CS, Hallman DM, Korshoj M, Carneiro IG, Holtermann A. Is objectively measured sitting time associated with low back pain? A cross-sectional investigation in the NOMAD study. PLoS One. 2015;10(3):18.

5. Caromano FA, Amorim C, Rebelo C, Contesini A, Fávero F, Frutuoso J, et al. Prolonged sitting and physical discomfort in university students. Acta Fisiátrica. 2015;22(4):176-81.

6. Jia B, Agnew M, Madigan M, Lockhart T, Perez M, Granata K. Influence of prolonged sitting and psychosocial on lumbar spine kinematics, Kinetics, discomfort and muscle fatigue: Virginia Polytechic Institute and stage university; 2013.

7. Watanabe S, Takahashi T, Takeba J, H M. Factors associated with the prevalence of back pain and work absence in shipyard workers. BMC Musculoskeletal Disorders. 2018;19(12):1-8.

8. Syazwan A, Azhar MM, Anita A, Azizan H, Shaharuddin M, Hanafiah JM, et al. Poor sitting posture and a heavy schoolbag as contributors to musculoskeletal pain in children: an ergonomic school education intervention program. Journal of pain Research. 2011;4:287-96.

9. Claus AP, Hides JA, Moseley GL, Hodges PW. Thoracic and lumbar posture behaviour in sitting tasks and standing: Progressing the biomechanics from observations to measurements. Applied Ergonomics. 2016;53:161-8.

10. Waongenngarm P, Rajaratnam BS, Janwantanakul P. Perceived body discomfort and trunk muscle activity in three prolonged sitting postures. The Journal of Physical Therapy Science. 2015;27:2183-7.

11. Hey HW, Wong CG, Lau ET, Tan KA, Lau LL, Liu KG, et al. Differences in erect sitting and natural sitting spinal alignment-insights into a new paradigm and implications in deformity correction. The Spine Journal. 2017;17(2):183-9.

12. Morl F, Bradl I. Lumbar posture and muscular activity while sitting during office work. Journal of Electromyography and Kinesiology. 2013;23(2):362-8.

13. Yu JS, An DH. Differences in lumbar and pelvic angles and gluteal pressure in different sitting postures. The Journal of Physical Therapy Science. 2015;27:1333-5.

14. Kumar SMR, Kumar CN. Design of Workstations for Computer Users: A Review. IRE Journals. 2017;1(4):24-36.

15. Grondin DE, Triano JJ, Tran S, Soave D. The effect of a lumbar support pillow on lumbar posture and comfort during a prolonged seated task. Chiropractic & Manual Therapies. 2013;21(21):1-9.

16. Kompayak S, Puntumetakul R, Karukunchit U, Peungsuwan P, Kamonrat T. A comparative study of the effectiveness of the use of a back care pillow and a lumbar support, as an adjuvant physical therapy in patients with chronic non-specific low back pain. Journal of Medical Technology and Physicla Therapy. 2016;2(28):165-76.

17. Hamaoui A, Hassaine M, Zanone PG. Sitting on a sloping seat does not reduce the strain sustained by the postural chain. PLoS One. 2015;10(1):1-14.

18. Chaiklienga S, Suggaravetsiri P, Stewart J. Incidence rate and risk factors associated with low back pain among university office workers in Thailand. Journal of the Medical Association of Thailand. 2015;93:142-8.

19. Rasul HNu, Malik AN, Siddiqi FA. Cross sectional survey of prevalence of low back pain in forward bend sitting posture. Rawal Medical Journal. 2013;38(3):253-7.

20. Hanna F, Daas RN, El-Shareif TJ, Al-Marridi HH, Al-Rojoub ZM, Adegboye OA. The Relationship Between Sedentary Behavior, Back Pain, and Psychosocial Correlates Among University Employees. Frontiers in Public Health. 2019;7(80):1-8.

21. Kanyenyeri L, Asiimwe B, Mochama M, Nyiligira J, Habtu M. Prevalence of Back Pain and Associated Factors among Bank Staff in Selected Banks in Kigali, Rwanda: A Cross Sectional Study. Health Science Journals. 2017;11(3):505-11.

22. Preece SJ, Willan P, Nester CJ, Graham-Smith P, Herrington L, Bowker P. Variation in Pelvic Morphology May Prevent the Identification of Anterior Pelvic Tilt. Journal of Manual & Manipulative Therapy. 2008;16(2):113-8.

23. O'Sullivan PB, Dankaerts W, Burnett AF, Farrell GT, Jefford E, Clare S. Naylor, et al. Effect of Different Upright Sitting Postures on Spinal- Pelvic Curvature and Trunk Muscle Activation in a Pain-Free Population. Spine. 2006;31(19):707-12.

24. O'Sullivan K, O'Dea P, Dankaerts W, O'Sullivan P, Clifford A, O'Sullivan L. Neutral lumbar spine sitting posture in pain-free subjects. Man Ther. 2010;15(6):557-61.

25. Moon MS, Lee H, Kim ST, Kim SJ, Kim MS, Kim DS. Spinopelvic Orientation on Radiographs in Various Body Postures: Upright Standing, Chair Sitting, Japanese Style Kneel Sitting, and Korean Style Cross-Legged Sitting. Clinics in Orthopedic Surgery. 2018;10(3):322-7.

26. Cho IY, Park SY, Park JH, Kim TK, Jung TW, Lee HM. The Effect of Standing and Different Sitting Positions on Lumbar Lordosis: Radiographic Study of 30 Healthy Volunteers. Asian Spine Journal. 2015;9(5):762-9.

27. Sheeran L, Hemming R, van Deursen R, Sparkes V. Can different seating aids influence a sitting posture in healthy individuals and does gender matter? Cogent Engineering. 2018;5(1):1-14.

28. Chaleat-Valayer E, Mac-Thiong JM, Paquet J, Berthonnaud E, Siani F, Roussouly P. Sagittal spino-pelvic alignment in chronic low back pain. European Spine Journal. 2011;20(5):634-40.

29. Pillai D, Haral P. Prevalence of Low Back Pain in Sitting Vs Standing Postures in Working Professionals in the Age Group of 30-60. International Journal of Health Sciences and Research. 2018;8(10):131-7.

30. Kim JW, Kang MH, Noh KH, Kim JS, Oh JS. A Sloped Seat Wedge Can Change the Kinematics of the Lumbar Spine of Seated Workers with Limited Hip Flexion. The

Journal of Physical Therapy Science. 2014;26:1173-5.

31. O'Keeffe M, Dankaerts W, O'Sullivan P, O'Sullivan L, O'Sullivan K. Specific flexion-related low back pain and sitting: comparison of seated discomfort on two different chairs. Ergonomics. 2013;56(4):650-8.

32. Curran M, Dankaerts W, O'Sullivan P, O'Sullivan L, O'Sullivan K. The effect of a backrest and seatpan inclination on sitting discomfort and trunk muscle activation in subjects with extension-related low back pain. Ergonomics. 2014;57(5):733-43.

33. Ward J, Coats J. Comparison of the BackJoy SitSmart Relief and Spine Buddy LT1 H/C Ergonomic Chair Supports on Short-Term Neck and Back Pain. Journal of Manipulative & Physiological Therapeutics. 2017;40:41-9.

34. Low FZ, Chua MCH, Lim PY, Yeow CH. Effects of Mattress Material on Body Pressure Profiles in Different Sleeping Postures. Journal of Chiropractic Medicine. 2017;16:1-9.

35. Ramli R, Mok K, Rubaizah F, Shamsul K, Tan K, Hashim A. Novel Deproteinised Natural Rubber Latex Slow-recovery Foam for Health Care and Therapeutic Foam Product Applications. Journal of Rubber Research. 2018;21(4):277-92.

36. Burge S. Pugh matrix. 2009. In: The systems engineering tool box [Internet].

37. Williamson A, Hoggart B. Pain: a review of three commonly used pain rating scales. Issues In Clinical Nursing. 2004:798-805.

38. Karcioglu O, Topacoglu H, Dikme O, Dikme O. A systematic review of the pain scales in adults: Which to use? The American Journal of Emergency Medicine. 2018;36(4):707-15.

39. Hjermstad MJ, Fayers PM, Haugen DF, Caraceni A, Hanks G, Loge JH, et al. Studies Comparing Numerical Rating Scales, Verbal Rating Scales, and Visual Analogue Scales for Assessment of Pain Intensity in Adults: A Systematic Literature Review. Journal of Pain and Symptom Management. 2011;41(6):1073-93.

40. Kelly A. The minimum clinically significant difference in visual analogue scale pain score does not differ with severity of pain. Emerency medical Journal. 2001;18:205-7.

41. Kendrick DB, Strout TD. The minimum clinically significant difference in patient-

assigned numeric scores for pain The American Journal of Emergency Medicine. 2005;23(7):828-35.

42. Nairn BC, Azar NR, Drake JDM. Transient pain developers show increased abdominal muscle activity during prolonged sitting. Journal of Electromyography and Kinesiology. 2013;23:1421-7.

43. Schinkel-Ivy A, Nairn BC, Drake JDM. Investigation of trunk muscle co-contraction and its association with low back pain development during prolonged sitting. Journal of Electromyography and Kinesiology. 2013;23:778-86.

44. Fenety PA, Putnam C, Walker JM. In-chair movement: validity, reliability and implications for measuring sitting discomfort. Applied Ergonomics. 2000;31 (4):383-93.

45. Fikri ZM, Haryati HR, Rahayu KS. Validity and reliability of vicon™ motion capture camera over the traditional anthropometric method. Malaysian Journal of Public Health Medicine 2018;2:142-51.

46. Perriman D, Scarvell J, Hughes A, Ashman B, Lueck C, Smith P. Validation of the Flexible Electrogoniometer for Measuring Thoracic Kyphosis. Spine. 2010;35(14):633-9.

47. Puig-Divı´ A, Escalona-Marfill C, Padulle´s-Riu JM, Busquets A, Padulle´s-Chando X, Marcos-Ruiz D. Validity and reliability of the Kinovea program in obtaining angles and distances using coordinates in 4 perspectives. PLOS One. 2019;14(6):1-14.

48. Santo CdMdE, Araújo RC. Assessment of changes in spine curvatures and the sensations caused in three different types of working seats. Motriz, Rio Claro. 2017;23(3):1-7.

49. Millar SK, Reid D, McDonnell L, editors. The Differences in Spinal Kinamatics and Loading in High Performance Female Rowers During Ergometer and on Water Rowing. International Society of Biomechanics in Sports; 2017; Auckland University of Technology, Auckland, New Zealand.

50. Horváth PG, Antal RM, Domljan D, Dénes L. Body Pressure Distribution Maps Used For Sitting Comfort Visualization. Sigurnost. 2017;59(2):123-32.

51. Akkarakittichoke N. The Study of Seat Pressure Distribution Pattern in Office Worker With and Without Chronic Low Back Pain Bangkok, Thailand: Chulalongkorn

University; 2015.

52. Rahman NIA, Dawal SZ, Yusoff N, Kamil NSM. Anthropometric measurements among four Asian countries in designing sitting and standing workstations. Sådhanå. 2018;43(10):1-9.

53. Adnan NMN, Patar MNAA, Lee H, Yamamoto S-I, Jong-Young L, Mahmud J. Biomechanical analysis using Kinovea for sports application. Materials Science and Engineering. 2018;348(01):2097-106.

54. Shafiei UKM, Karuppiah K, Tamrin SBM, Meng GY, Rasdia I, Alias AN. The effectiveness of new model of motorcycle seat with built-in lumbar support. Jurnal Teknologi. 2015;77(27):97-103.

55. Waongenngarm P, Areerak K, Janwantanakul P. The effects of breaks on low back pain, discomfort, and work productivity in office workers: A systematic review of randomized and non-randomized controlled trials. Applied Ergonomics. 2018; 68:230-9.

56. Teraguchi M, Yoshimura N, Hashizume H, Muraki S, Yamada H, Minamide A, et al. Prevalence and distribution of intervertebral disc degeneration over the entire spine in a population-based cohort: the Wakayama Spine Study. Osteoarthritis and Cartilage. 2014;22:104-10.

57. Carvalho DD, Grondin D, Callaghan J. The impact of office chair features on lumbar lordosis, intervertebral joint and sacral tilt angles: a radiographic assessment. Ergonomics. 2017;60(10):1393-405.

58. Mandal AC. The seated man (Homo Sedens) The seated work and practice position. Theory. Applied Ergonomics. 1981;12(1):19-27.

59. Sheeran L, Sparkes V, Busse M, Deursen Rv. Preliminary study: reliability of the spinal wheel. A novel device to measure spinal postures applied to sitting and standing. European Spine Journal. 2010;19(6).

60. O'Sullivan K, McCarthy R, White A, O'Sullivan L, Dankaerts W. Can we reduce the effort of maintaining a neutral sitting posture? A pilot study. Manual Therapy. 2012;17:566-71.

61. Chevillotte T, Coudert P, Cawley D, Bouloussa H, Mazas S, Boissière L, et al.

Influence of posture on relationships between pelvic parameters and lumbar lordosis: Comparison of the standing, seated, and supine positions. A preliminary study. Orthopaedics & Traumatology: Surgery & Research. 2018;104(5):565-8.

62. Caneiro JP, O'Sullivan P, Burnett A, Barach A, O'Neil D, Tveit O, et al. The influence of different sitting postures on head/neck posture and muscle activity. Manual Therapy. 2009;15:54-60.

63. Reham M. Abd Elrahima, Eman A. Embabya, Mohamed F. Alib, Kamel RM. Inter-rater and intra-rater reliability of Kinovea software for measurement of shoulder range of motion. Bulletin of Faculty of Physical Therapy. 2016;21:80-7.

64. Pillastrini P, Mugnai R, Bertozzi L, Costi S, Curti S, Guccione A, et al. Effectiveness of an ergonomic intervention on work-related posture and low back pain in video display terminal operators: A 3 year cross-over trial. Applied Ergonomics. 2010;41:436-43.

65. Jensen M, Chen C, Brugger A. Interpretation of Visual Analog Scale Ratings and Change Scores: A Reanalysis of Two Clinical Trials of Postoperative Pain. Journal of the American Pain Society. 2003;4:407-14.

66. van Vledder N, Louw Q. The effect of a workstation chair and computer screen height adjustment on neck and upper back musculoskeletal pain and sitting comfort in office workers. South African Journal of Physiotherapy. 2015;71(1):279-88.

67. AmickIII B, Robertson M, DeRango K, Bazzan L, Moore A, Rooney T, et al. Effect of Office Ergonomics Intervention on Reducing Musculoskeletal Symptoms. Spine. 2003;28(24):2706-11.

Appendix

Appendix A

THE CERTIFICATE OF ETHICAL APPROVAL

MF-04-version-2.0
วันที่ 18 ต.ค. 61

หนังสือรับรองจริยธรรมการวิจัยของข้อเสนอการวิจัย
เอกสารข้อมูลคำอธิบายสำหรับผู้เข้าร่วมการวิจัยและใบยินยอม

หมายเลขข้อเสนอการวิจัย SWUEC-G- 196/2563E

ข้อเสนอการวิจัยนี้และเอกสารประกอบของข้อเสนอการวิจัยตามรายการแสดงด้านล่าง ได้รับการพิจารณาจากคณะกรรมการจริยธรรมสำหรับพิจารณาโครงการวิจัยที่ทำในมนุษย์ มหาวิทยาลัยศรีนครินทรวิโรฒแล้ว คณะกรรมการฯ มีความเห็นว่าข้อเสนอการวิจัยที่จะดำเนินการมีความสอดคล้องกับหลักจริยธรรมสากล ตลอดจนกฎหมาย ข้อบังคับและข้อกำหนดภายในประเทศ จึงเห็นสมควรให้ดำเนินการวิจัยตามข้อเสนอการวิจัยนี้ได้

ชื่อโครงการวิจัยเรื่อง: นวัตกรรมเบาะหนุนรองนั่งเพื่อช่วยปรับท่าทางของกระดูกสันหลังส่วนเอวและกระดูกเชิงกรานในท่านั่งของกลุ่มพนักงานออฟฟิศ

ชื่อผู้วิจัยหลัก: นาย วิธวินท์ แซ่ลี้

สังกัด: คณะกายภาพบำบัด

เอกสารที่รับรอง:
1. แบบเสนอโครงการวิจัย
2. โครงการวิจัย
3. เอกสารชี้แจงผู้เข้าร่วมการวิจัย
4. หนังสือให้ความยินยอมเข้าร่วมโครงการวิจัย

เอกสารที่พิจารณาทบทวน

1. แบบเสนอโครงการวิจัย	ฉบับที่ 2 วัน/เดือน/ปี 19 สิงหาคม 2563
2. โครงร่างการวิจัย	ฉบับที่ 2 วัน/เดือน/ปี 19 สิงหาคม 2563
3. เอกสารชี้แจงผู้เข้าร่วมการวิจัย	ฉบับที่ 2 วัน/เดือน/ปี 19 สิงหาคม 2563
4. หนังสือให้ความยินยอมเข้าร่วมโครงการวิจัย	ฉบับที่ 2 วัน/เดือน/ปี 19 สิงหาคม 2563

(ลงชื่อ)..

(ผู้ช่วยศาสตราจารย์ ดร.ทันตแพทย์หญิงณปภา เอี่ยมจิรกุล)

กรรมการและเลขานุการคณะกรรมการจริยธรรมสำหรับพิจารณาโครงการวิจัยที่ทำในมนุษย์

(ลงชื่อ)..

(แพทย์หญิงสุรีพร ภัทรสุวรรณ)

ประธานคณะกรรมการจริยธรรมสำหรับพิจารณาโครงการวิจัยที่ทำในมนุษย์

หมายเลขรับรอง : SWUEC/E/G-196/2563

วันที่ให้การรับรอง : 19/08/2563

วันหมดอายุใบรับรอง : 19/08/2564

เอกสารรับรองโครงการวิจัย

โดยคณะกรรมการจริยธรรมในมนุษย์

คณะกายภาพบำบัด มหาวิทยาลัยศรีนครินทรวิโรฒ

เอกสารรับรองเลขที่	PTPT2020-009
ชื่อโครงการ :	**นวัตกรรมเบาะหนุนรองนั่งเพื่อช่วยปรับท่าทางของกระดูกสันหลังส่วนเอว และกระดูกเชิงกรานในท่านั่งของกลุ่มพนักงานออฟฟิศ**
ชื่อหัวหน้าโครงการ :	**นายวิธวินท์ แซ่ลี้**
หน่วยงานที่สังกัด :	**สาขากายภาพบำบัด**
เอกสารที่รับรอง :	1. แบบเสนอโครงการวิจัย 2. เอกสารชี้แจงผู้เข้าร่วมการวิจัย 3. หนังสือยินยอมตนให้ทำการวิจัย 4. แบบการเก็บรวบรวมข้อมูล/โปรแกรมหรือกิจกรรม
วันที่รับรอง :	**30 กรกฎาคม 2563**
วันที่หมดอายุ :	**29 กรกฎาคม 2564**

ขอรับรองว่าโครงการดังกล่าวข้างต้นได้ผ่านการพิจารณาเห็นชอบโดยสอดคล้องกับคำประกาศเฮลซิงกิ จากคณะกรรมการจริยธรรมในมนุษย์ คณะกายภาพบำบัด มหาวิทยาลัยศรีนครินทรวิโรฒ **ออกให้ ณ วันที่....13....สิงหาคม 2563**

ลงนาม.....ชัชฎา ชินกุลประเสริฐ.....

(ผู้ช่วยศาสตราจารย์ ดร.ชัชฎา ชินกุลประเสริฐ)

ประธานคณะกรรมการจริยธรรมในมนุษย์

ลงนาม...

(รองศาสตราจารย์ ดร.รัมภา บุญสินสุข)

คณบดีคณะกายภาพบำบัด

Appendix B

OSHA WORKSTATION CHECKLIST

Computer Workstations eTool

Checklists » Evaluation

This checklist can help you create a safe and comfortable computer workstation. You can also use it in conjunction with the purchasing guide checklist. A "no" response indicates that a problem may exist. Refer to the appropriate section of the eTool for assistance and ideas about how to analyze and control the problem.

Print Checklist

WORK STATIONS - Arrange and adjust the computer workstation to promote neutral postures.	Y
1. Head and neck are balanced and in-line with torso (ears directly above the shoulders not bent forward or back). If "no" refer to Monitors, Chairs and Work Surfaces.	☐
2. Head, neck, and trunk facing forward (not twisted to view monitor/work/documents). If "no" refer to Monitors or Chairs.	☐
3. Torso is vertical to slightly reclined (see recommendations in Good Working Postures). If "no" refer to Chairs or Monitors.	☐
4. Back is fully supported by chair lumbar support. If "no" refer to Seating.	☐
5. Shoulders are relaxed (not elevated). Upper arms Shoulders are relaxed (not elevated). Upper arms are in-line with torso, (not elevated or stretched forward unless supported by work surface). If "no" refer to Chairs.	☐
6. Elbows are close to the body (not extended forward or outward unless supported by work surface or chair armrests). If "no" refer to Chairs, Work Surfaces, Keyboards, and Pointers.	☐
7. Forearms are approximately parallel to the floor and about 90 to 100 degrees to the upper arm. If "no" refer to Chairs, Keyboards, Pointers.	☐
8. Wrists and hands are straight in alignment to the forearm (not bent up/down or sideways). If "no" refer to Keyboards, or Pointers	☐
9. Thighs are approximately parallel to the floor (and lower legs are approximately perpendicular to floor (thighs may be slightly elevated above knees see recommendations in Good Working Posture for declined seated postures). If "no" refer to Chairs or Work Surfaces.	☐
10. There should be sufficient room under the work surface so thighs have clearance space between the top of the thighs and the computer table/keyboard platform (thighs are not trapped).	☐

11. Legs and feet have sufficient forward clearance under the work surface so the user is able to get close to the keyboard/input device.	☐
12. Feet rest flat on the floor or are supported by a stable footrest if the work surface cannot be adjusted. If "no" refer to Chairs, Work Surfaces.	☐
13. Sharp or square edges that contact hands, wrists, or forearms are padded or rounded. If "no" refer to Work Surfaces.	☐

SEATING - Consider these points when evaluating the chair.	Y
1. Backrest has height adjustability so support is provided for the lower back (lumbar area).	☐
2. Chair has a sturdy 5 leg base.	☐
3. Seat width and depth should accommodate the specific user (seat pan should be wide enough for ease of egress and deep enough to support the entire thigh but not so deep that user cannot utilize lumbar support.)	☐
4. Seat front does not press against the back of users knees and lower legs (seat pan not too long). Thighs do not significantly hang off the front edge of the seat. (Seat pan not too short).	☐
5. Seat is cushioned and rounded with a "waterfall" front (no sharp edge).	☐
6. Seat height is adjustable and allows for proper alignment with the work surface.	☐
7. Armrests, if used, should be adjustable (both up and down and in and out) and support both forearms while user performs computer tasks. They should not interfere with movement or positioning of the chair under the work surface.	☐
8. Head Rest (if provided) is adjustable and does not push the head forward past neutral.	☐
9. Casters are appropriate for the floor surface. (They move easily on carpet of other soft surfaces but do not move so easily on tile or hard surfaces that the chair "scoots" away during sitting down or getting up from chair).	☐
10. Adjustments are straight forward and easy to perform while seated in the chair.	☐
"No" answers to any of these questions should prompt a review of Chairs.	

KEYBOARD/INPUT DEVICE - Consider these points when evaluating the keyboard or pointing device (mouse, trackball, touch pen, roller mouse, joy stick, etc.).	Y
1. Keyboard/input device platform(s) is stable and large enough to hold a keyboard and an input device.	☐
2. Keyboard/input device platform(s) can be adjusted so the hands are positioned over the keyboard with the elbows near the torso at an angle of 90 to 100 degrees. (See suggestions in Good Working Postures).	☐
3. Keyboard can be adjusted to a horizontal or slightly negative slope.	☐

4. Input device (mouse or trackball) is located right next to the keyboard so it can be operated without reaching.	☐
5. Input device is easy to activate and the shape/size fits hand (not too big/small). It may be desirable to have an input device that can be used with either hand to provide periods of working rest.	☐
6. Input device is located as close to the midline of the body as possible and at the same level as the keyboard.	☐
7. If a touchscreen device is used for data input, a detached keyboard and mouse are available if duration of use is more than 2 hours per day or 30 minutes at a time.	☐
8. There are no sharp or hard edges that contact the wrists and hands.	☐
"No" answers to any of these questions should prompt a review of Keyboards,Pointers,or Wrist Rests.	

MONITOR – Consider these points when evaluating the monitor and its placement.	**Y**
1. The monitor has sufficient adjustability so the top of the screen is at or below eye level so the user can read it without bending their head or neck down/back.	☐
2. Adjustability is sufficient so users with bifocals/trifocals can read the screen without bending the head or neck backward.	☐
3. There is sufficient room so the monitor can be placed at a distance which allows the user to read the screen without leaning head, neck or trunk forward/backward. (Generally, about 18 to 20 inches or arm length)	☐
4. Monitor position is directly in front of the user so they do not have to twist head or neck.	☐
5. If multiple monitors are used, the position of the primary monitor is directly in front of the user and the other monitors are directly beside it. If time is split evenly between monitors, they are next to each other within a comfortable viewing angle with minimal head movement.	☐
6. Glare (from windows, lights) is not reflected on screen causing the user to squint or assume awkward postures to clearly see information on the screen.	☐
7. Monitor brightness and contrast is adjusted for comfort.	☐
"No"answers to any of these questions should prompt a review of Monitors or Lighting/Glare.	

MOBILE DEVICES	**Y**
1. If laptops are used as a primary computer they are set up using the same ergonomic principles as desktop computers. A separate keyboard and input device are provided.	☐
2. If laptops are used outside the office, (e.g. on a plane, in a hotel) user postures should be changed regularly to improve neck and wrist posture and duration of time on laptop should be minimized.	☐

3. Laptops used in vehicles are set up at a comfortable angle and infrequent use. The user should take frequent breaks from computer tasks.	☐
4. A separate keyboard and stylus are available when tablets are used for typing performed for extended periods of time.	☐
5. Tablets and smartphones should be used with the shoulders relaxed, arms positioned near the torso, and neck in a neutral posture without excessive neck bending to view the screen.	☐

ACCESSORIES	**Y**
1. Document holder, if provided, is stable and large enough to hold documents (paper, binders, or books).	☐
2. Document holder, if provided, is placed at about the same height and distance as the monitor screen.	☐
3. Wrist/palm rest, if provided, is padded and free of sharp or square edges that contact the wrists.	☐
4. Wrist/palm rest, if provided, allows user you to keep your forearms, wrists, and hands straight and in-line when using the keyboard/input device. Height matches the front edge of the keyboard.	☐
5. Telephone is positioned close to the work to avoid excessive reaches. Generally, within 18 to 20 inches.	☐
6. Telephone can be used with head upright (not bent) and shoulders relaxed. If phone and computer are used at the same time, this may require the use of a headset.	☐
7. Headset, if used, has a comfortable fit. Not too tight, or so loose that if will not maintain its position on the users head.	☐
8. Footrest is provided if the feet are not flat on the floor because the keyboard and monitor do not have sufficient adjustability. If used the footrest should be angled and support both feet.	☐
"No" answers to any of these questions should prompt a review of Work Surfaces, Document Holders, Wrist Rests or Telephones.	

GENERAL CONCEPTS	**Y**
1. Workstation and equipment have sufficient adjustability so users are in a safe/supportive working posture and can easily make occasional changes in posture while performing computer tasks.	☐
2. Computer workstation, components and accessories are maintained in serviceable condition and function properly.	☐
3. Items that must be accessed frequently are within easy reach, generally with the elbows close the body. Items used occasionally can be at nearly full arm reach.	☐

4. Computer tasks are organized in a way that allows users to vary keyboard tasks with other work activities, or provide an opportunity for micro-breaks or recovery pauses while at the computer workstation.	☐
5. User has the ability to alternate between sitting and standing postures or activities to provide *opportunities for movement and variability throughout the shift.* Prolonged sitting *or* standing should be avoided.	☐
6. Lighting levels are adjustable for differing tasks. Brighter task lights should be provided for paperwork and lower lighting should be used for general computer work.	☐
"No" answers to any of these questions should prompt a review of Chairs, Work Surfaces, or Work Processes.	

Appendix C

COVID-19 SCREENING QUESTIONAIRE

แบบประเมินคัดกรองผู้รับบริการก่อนการให้บริการ

วัตถุประสงค์ : แบบสอบถามก่อนเข้าใช้บริการสถานประกอบการเพื่อสุขภาพนี้ เพื่อคัดกรองให้เกิดความปลอดภัยแก่ผู้มาใช้บริการและผู้เกี่ยวข้อง แบบสอบถามนี้เป็นการประเมินตนเองเบื้องต้นเท่านั้น การตัดสินใจให้การบริการทางสถานประกอบการเพื่อสุขภาพขึ้นอยู่กับดุลยพินิจของผู้ให้บริการ

ชื่อ-สกุล..เบอร์โทรศัพท์ที่สามารถติดต่อได้.......................................

ที่ตั้งเลขที่..................ถนน..............................ตำบล/แขวง..............................อำเภอ/เขต......................................

จังหวัด..............................รหัสไปรษณีย์.....................................

คำชี้แจง โปรดทำเครื่องหมาย / ลงใน (ใช่) หรือ (ไม่ใช่) หรือเติมข้อความในช่องว่างที่ตรงกับตัวท่านมากที่สุด

ลำดับที่	รายละเอียด/ประวัติอาการและอาการแสดง	ใช่	ไม่ใช่	หมายเหตุ
1	มีไข้ ≥37.3 องศาเซลเซียส			
2	2.1 สัมผัสหรืออยู่ใกล้ชิดกับผู้ป่วยโรคโควิด-19			
	2.3 มีประวัติเดินทางกลับจากต่างประเทศ (ถ้ามีระบุประเทศ..............................ถึงไทย ณ วันที่......................)			
	2.4 มีประวัติเดินทางออกนอกพื้นที่อาศัยอยู่ภายใน 14 วัน (เดินทางไปอำเภอ.................จังหวัด.....................วันที่ไป...........)			
3	**ท่านมีอาการเหล่านี้หรือไม่** 3.1 รู้สึกครั่นเนื้อครั่นตัวอ่อนเพลีย			
	3.2 ไอ/ไอแห้ง/ไอมีเสมหะ			
	3.3 มีน้ำมูก			
	3.4 เจ็บคอ			
	3.5 ปวดศีรษะ			
	3.6 หายใจลำบาก/หอบเหนื่อย/เจ็บหน้าอก			
	3.7 มีอาการได้ยินเสียงที่ผิดปรกติหรือเริ่มมีปัญหาการได้ยิน			
	3.8 จมูกไม่ได้กลิ่น หรือได้กลิ่นลดลง			
	3.9 ลิ้นไม่รู้รส หรือลิ้นได้รับรู้รสน้อยลง			
	3.10 ท่านรับประทานยาอะไรบ้างเพื่อบรรเทาอาการในข้อ 3.1-3.9 เช่น..			
4	ท่านเป็นบุคลากรทางการแพทย์หรือสาธารณสุขที่สัมผัสกลุ่มเสี่ยงผู้ป่วยโควิดหรือไม่			

ข้าพเจ้ายืนยันว่า ข้อมูลดังกล่าวเป็นความจริงทุกประการ จึงขอลงลายมือชื่อไว้เป็นหลักฐานประกอบคำยืนยัน

ลงชื่อ...

(...)

ลงชื่อผู้คัดกรอง...

(...)

ขอขอบคุณทุกท่านที่ให้ความร่วมมือเป็นอย่างดี

Appendix D

SCREENING QUESTIONAIRE

แบบสอบถามข้อมูล

แบบสอบถามนี้เป็นการเก็บข้อมูลพื้นฐานเพื่อเป็นเกณฑ์การคัดกรองอาสาสมัครผู้เข้าร่วมโครงการวิจัยเรื่อง นวัตกรรมเบาะหนุนรองนั่งเพื่อช่วยปรับท่าทางของกระดูกสันหลังส่วนเอวและกระดูกเชิงกรานในท่านั่งของกลุ่มพนักงานออฟฟิศ ซึ่งศึกษาเปรียบเทียบการเปลี่ยนแปลงของมุมของกระดูกสันหลังส่วนล่าง,มุมกระดูกเชิงกรานและอาการปวด **ขณะนั่งทำงานบนโต๊ะโดยใช้และไม่ใช้นวัตกรรมเบาะหนุนรองนั่ง** ภายใต้การดูแลของ คณะกายภาพบำบัด มหาวิทยาลัยศรีนครินทรวิโรฒ โดยมิได้มีวัตถุประสงค์เพื่อการอื่นใดจากที่กล่าวมาข้างต้น โดยการนำเสนอข้อมูลที่ได้จากท่านจะไม่มีการเปิดเผยชื่อและนามสกุลของอาสาสมัครและไม่มีการเปิดเผยข้อมูลรายบุคคล แต่จะเสนอข้อมูลโดยภาพรวม

โปรดทำเครื่องหมาย✓ลงในช่อง ☐ ตามความเป็นจริง

1.) ชื่อ - นามสกุล...อายุ.......................ปี

เพศ ☐ ชาย ☐ หญิง ส่วนสูง..................ซม. น้ำหนัก.......................กก. (BMI.....................Kg/M²)

2.) ชีวิตประจำวันท่านนั่งทำงานหรือทำกิจกรรมบนเก้าอี้ รวมมากกว่า 6 ชั่วโมงต่อวันหรือไม่ (หากใช่กรุณาทำแบบสอบถามต่อไป)

☐ ใช่ ☐ ไม่

3.) หากท่านนั่งทำงานหรือทำกิจกรรมบนเก้าอี้ รวมมากกว่า 6 ชั่วโมงต่อวันท่านมีพฤติกรรมเช่นนี้มาเป็นระยะเวลานานเท่าไหร่

☐ น้อยกว่า 1 ปี ☐ 1-5 ปี ☐ มากกว่า 5ปี

4.) ท่านเคยประสบปัญหามีอาการปวดเมื่อยบริเวณหลังส่วนล่างขณะนั่งทำงานหรือทำกิจกรรมต่างๆหรือไม่ (หากใช่กรุณาทำแบบสอบถามต่อไป)

☐ ใช่ ☐ ไม่

5.) ปัจจุบันท่านมีอาการปวดเมื่อยบริเวณหลังส่วนล่างขณะนั่งทำงานหรือทำกิจกรรมต่างๆหรือไม่

☐ ใช่ ☐ ไม่

โปรดทำแบบสอบถามต่อหน้าถัดไป

6.) หากท่านมีอาการปวดเมื่อยบริเวณหลังส่วนล่างขณะนั่งทำงานหรือทำกิจกรรมต่างๆอาการปวดของท่านอยู่ในระดับใด โปรดใช้ปากกาลากเส้นเหนือด้านล่างโดยลากจากซ้ายไปขวา โดยความยาวของเส้นแทนระดับความรู้สึกปวดเมื่อยของท่าน

ไม่ปวด ปวดรุนแรงมากที่สุด

ข้าพเจ้าขอรับรองว่าข้อมูลในข้างต้นเป็นความจริงทั้งหมด

ลงชื่อ____________________________

(________________________________)

สำหรับผู้เก็บข้อมูล

ผลการสุ่มลำดับการนั่ง

.................นั่งบนเก้าอี้มาตรฐาน

.... นั่งบนเก้าอี้มาตรฐานร่วมกับการใช้เบาะรองนั่งรูปแบบ Pelvic cushion design

.................นั่งบนเก้าอี้มาตรฐานร่วมกับการใช้เบาะรองนั่งรูปแบบ Lumbo-pelvic cushion design

Appendix E

PARTICIPANT INFORMATION SHEET

เอกสารชี้แจงผู้เข้าร่วมการวิจัย

(Participant Information Sheet)

ในเอกสารนี้อาจมีข้อความที่ท่านอ่านแล้วยังไม่เข้าใจ โปรดสอบถามหัวหน้าโครงการวิจัยหรือผู้แทนให้ช่วยอธิบายจนกว่าจะเข้าใจดี ท่านอาจจะขอเอกสารนี้กลับไปอ่านที่บ้านเพื่อปรึกษา หารือกับญาติพี่น้อง เพื่อนสนิท แพทย์ประจำตัวของท่าน หรือแพทย์ท่านอื่น เพื่อช่วยในการตัดสินใจเข้าร่วมการวิจัย

ชื่อโครงการวิจัย นวัตกรรมเบาะหนุนรองนั่งเพื่อช่วยปรับท่าทางของกระดูกสันหลังส่วนเอวและกระดูกเชิงกรานในท่านั่งของกลุ่มพนักงานออฟฟิศ

ชื่อหัวหน้าโครงการวิจัย นายวิธวินท์ แซ่ลี้

ผู้ช่วยศาสตราจารย์ ดร. ภัทริยา อินทร์โท่โล่

ผู้ช่วยศาสตราจารย์ ดร. ณัฐพงษ์ คงประเสริฐ

สถานที่วิจัย คณะกายภาพบำบัด มหาวิทยาลัยศรีนครินทรวิโรฒ

สถานที่ทำงานและหมายเลขโทรศัพท์ของหัวหน้าโครงการวิจัยที่ต่อได้ทั้งในและนอกเวลาราชการ

นายวิธวินท์ แซ่ลี้ คณะกายภาพบำบัด มหาวิทยาลัยศรีนครินทรวิโรฒ (องครักษ์) อ องครักษ์ จ นครนายก 26120 โทร 098-9254295

ผู้สนับสนุนทุนวิจัย คณะวิศวะกรรมศาสตร์ มหาวิทยาลัยศรีนครินทรวิโรฒ

ระยะเวลาในการวิจัย 12 เดือน

โครงการวิจัยนี้ทำขึ้นเพื่อ เปรียบเทียบองศาของกระดูกสันหลังส่วนอก, กระดูกสันหลังส่วนเอว, มุมการหมุนของกระดูกเชิงกรานและการรับรู้ความรู้สึกปวดระหว่างการใช้นวัตกรรมเบาะรองนั่ง2 รูปแบบ และไม่ใช้เบาะรองนั่งในกลุ่มพนักงานออฟฟิศ ช่วงวัยทำงานที่มีพฤติกรรมนั่งเป็นระยะเวลานานรวมมากกว่า 6 ชั่วโมงต่อวัน

ประโยชน์ที่คาดว่าจะได้รับจากการวิจัย คือ 1.ได้รับผลการเปรียบเทียบขององศาของกระดูกสันหลังส่วนอก และส่วนเอว, มุมการหมุนของกระดูกเชิงกรานจะอยู่ในองศาที่ปกติและการรับความรู้สึกปวดระหว่างการใช้นวัตกรรมเบาะรองนั่ง 2รูปแบบจะน้อยกว่าไม่ใช้เบาะรองนั่งในขณะนั่งทำงาน

2. สามารถพัฒนาผลงานต้นแบบนวัตกรรมเบาะรองนั่งที่สามารถปรับปรุงท่าทางของกระดูกสันหลังส่วนเอวและป้องกันอาการปวดขณะนั่งทำงานในกลุ่มพนักงานออฟฟิศอย่างมีประสิทธิภาพ

คณะกรรมการจริยธรรมในมนุษย์
คณะกายภาพบำบัด มหาวิทยาลัยศรีนครินทรวิโรฒ
รหัส PTPT 2020 – 009
วันที่ 30 ก.ค. 63 ถึง 29 ก.ค. 64

ท่านได้รับเชิญให้เข้าร่วมการวิจัยนี้เพราะ ท่านเป็นผู้ปฏิบัติงานในรูปแบบของพนักงานออฟฟิศ ที่อยู่ในช่วงอายุ 18-59ปี มีสุขภาพดี ที่มีประสบการณ์การนั่งทำงานหน้าคอมพิวเตอร์เป็นระยะเวลานานรวมมากกว่า 6 ชั่วโมงต่อวัน รวมมากกว่า 41 ชั่วโมงต่อสัปดาห์และติดต่อกันมากว่า 12 เดือน ดัชนีมวลกายอยู่ในเกณฑ์มาตรฐานในช่วง 18.5 - 25 kg/m² ไม่มีอาการปวดบริเวณหลังส่วนล่างหรือมีอาการปวดเล็กน้อยโดยที่สามารถจัดการอาการปวดของตนเองได้ด้วยการพักผ่อน(ค่าแบบประเมินระดับความปวด Visual analog scale = 1-3), ไม่มีสภาวะความผิดปกติทางระบบกระดูกและกล้ามเนื้อทั้งในระยะเฉียบพลันและระยะเรื้อรัง, ไม่มีประวัติเข้ารับการผ่าตัดบริเวณกระดูกสันหลังและกระดูกเชิงกราน, ไม่มีสภาวะผิดปกติทางด้านระบบประสาท, ไม่ได้พบบุคคลากรทางการแพทย์ทุกประเภทเพื่อรับการรักษาอาการปวดและไม่ได้รับประทานยาแก้ปวดหรือยาคลายกล้ามเนื้อก่อนเข้าร่วมวิจัย 2 สัปดาห์

จะมีผู้เข้าร่วมการวิจัยนี้ทั้งสิ้น 36 คน

หากท่านตัดสินใจเข้าร่วมการวิจัยแล้ว จะมีขั้นตอนการวิจัยดังต่อไปนี้คือ

1. ผู้เข้าร่วมการศึกษาจะถูกสุ่มลำดับของรูปแบบการนั่งโดยมีทั้งหมด 3 รูปแบบคือ 'นั่งบนเก้าอี้มาตรฐาน', 'นั่งบนเก้าอี้มาตรฐานร่วมกับการใช้เบาะรองนั่งรูปแบบ Pelvic cushion design' และ 'นั่งบนเก้าอี้มาตรฐานร่วมกับการใช้เบาะรองนั่งรูปแบบ Lumbo-pelvic cushion design'
2. ผู้เข้าร่วมการศึกษาจะต้องเปลี่ยนชุดเป็นชุดรัดรูปตามที่ผู้วิจัยได้จัดเตรียมไว้ให้
3. ผู้วิจัยจะทำการติดมาร์คเกอร์ขนาดเส้นผ่านศูนย์กลาง 18 มม.บนปุ่มกระดูกสันหลังระดับ T1, T5, T10, L3 และ S2 และปุ่มกระดูกเชิงกรานด้านหน้าและกระดูกเชิงกรานด้านหลัง โดยใช้วิธีการคลำสัมผัสตามหลักการทางกายวิภาคศาสตร์เพื่อระบุตำแหน่งของปุ่มกระดูกดังกล่าว ใช้เวลาประมาณ 5-10นาที
4. ผู้เข้าร่วมวิจัยนั่งบนเก้าอี้ที่จัดเตรียมไว้หน้าคอมพิวเตอร์ จากนั้นผู้วิจัยจะปรับความสูงของเก้าอี้และ พื้นที่ของโต๊ะทำงานคอมพิวเตอร์ให้เหมาะสมกับผู้เข้าร่วมวิจัยด้วยแบบประเมิน OSHA ซึ่งเป็นแบบประเมินสำหรับปรับปรุงพื้นที่ในการทำงานคอมพิวเตอร์ ใช้เวลาประมาณ 5-10 นาที
5. ผู้วิจัยจะอธิบายเกี่ยวกับงานโดยให้ผู้เข้าร่วมวิจัยนั่งตัวตรงไม่มีการหมุนหรือบิดของลำตัวเพื่อความถูกต้องในการบันทึกข้อมูลและทำการพิมพ์ลงบนแป้นพิมพ์ที่ถูกจัดเตรียมไว้บนโปรแกรม Microsoft word โดยกำหนดให้พิมพ์ตามบทความที่จัดไว้ให้โดยผู้วิจัย และให้ผู้เข้าร่วมวิจัยทำการบันทึกตำแหน่งและระดับอาการปวดของกล้ามเนื้อในช่วงนาทีที่ 0

และ 10 ของการนั่งทำงาน บนเครื่องมือ Body pain chart ในขณะเดียวกันผู้วิจัยจะทำการบันทึกภาพวีดีทัศน์ผ่านกล้องที่จัดเตรียมไว้ทางด้านขวาของผู้เข้าร่วมวิจัยเป็นระยะเวลา 5 วินาที ในช่วงนาทีที่ 0 และ 10 ของการนั่งทำงาน

6. เริ่มการนั่งในรูปแบบที่ 1 และพิมพ์ข้อความบนคอมพิวเตอร์ ของผู้เข้าร่วมวิจัยเป็นเวลา 10 นาที
7. พัก 10 นาทีด้วยท่านอนหงายรองหมอนใต้เข่าบนเตียงที่ผู้วิจัยได้จัดเตรียมไว้
8. เริ่มการนั่งในรูปแบบที่ 2 และพิมพ์ข้อความบนคอมพิวเตอร์ ของผู้เข้าร่วมวิจัยเป็นเวลา 10 นาที
9. พัก 10 นาทีด้วยท่านอนหงายรองหมอนใต้เข่าบนเตียงที่ผู้วิจัยได้จัดเตรียมไว้
10. เริ่มการนั่งในรูปแบบที่ 3 และพิมพ์ข้อความบนคอมพิวเตอร์ ของผู้เข้าร่วมวิจัยเป็นเวลา 10 นาที

การประเมินคือ วัดองศาของมุมกระดูกสันหลังและเชิงกราน ระดับอาการปวด

- **รวมระยะเวลาที่ท่านต้องร่วมอยู่ในโครงการวิจัยโดยประมาณที่ 1 ชั่วโมง จำนวนครั้งที่จะนัดหมาย 1 ครั้ง และเวลาที่ใช้ในการนัดหมาย 1 ชั่วโมง**

ความเสี่ยงที่อาจจะเกิดขึ้นเมื่อเข้าร่วมการวิจัย

1. เสี่ยงที่จะมีภาวะปวดจากเอ็นกล้ามเนื้อหรือกล้ามเนื้ออักเสบ จากการนั่งทำงานคอมพิวเตอร์

วิธีแก้ไข : โดยหากมีอาการดังกล่าว และประสงค์จะหยุดการดำเนินการ ให้แจ้งผู้วิจัย โดยผู้วิจัยจะมีเครื่องมือ ปฐมพยาบาล เบื้องต้น เช่น cold pack, Reparil gel เป็นต้น และมีการให้การรักษาทางกายภาพบำบัดด้วยอุปกรณ์ Ultrasound therapy โดยจะรักษาจนกระทั่งอาการหายไป โดยไม่เสียค่าใช้จ่ายใดๆ

หากท่านไม่เข้าร่วมในโครงการวิจัยนี้ <u>จะไม่มีผลกระทบต่อหน้าที่การปฏิบัติงานใดๆ ของท่าน</u>

หากมีข้อข้องใจที่จะสอบถามเกี่ยวข้องกับการวิจัย หรือหากเกิดผลข้างเคียงที่ไม่พึงประสงค์จากการวิจัย ท่านสามารถติดต่อ ผศ. ดร. ภัทริยา อินทร์โทโล่ คณะกายภาพบำบัด มหาวิทยาลัยศรีนครินทร-วิโรฒ (องครักษ์) อ องครักษ์ จ นครนายก 26120 โทร 084-944-5859

คณะกรรมการจริยธรรมในมนุษย์
คณะกายภาพบำบัด มหาวิทยาลัยศรีนครินทรวิโรฒ
รหัส PTPT 2020-009
วันที่ 30 ก.ค. 63 ถึง 29 ก.ค. 64

ท่านจะได้รับการช่วยเหลือหรือดูแลรักษาการบาดเจ็บ/เจ็บป่วยอันเนื่องมาจากการวิจัยตามมาตรฐานทางการแพทย์ โดยผู้รับผิดชอบค่าใช้จ่ายในการรักษาคือ ผศ. ดร.ภัทริยา อินทร์โท่โล่ โทร 084-944-5859

ประโยชน์ที่คิดว่าจะได้รับจากการวิจัย สามารถพัฒนาผลงานต้นแบบนวัตกรรมเบาะรองนั่งที่สามารถปรับปรุงท่าทางของกระดูกสันหลังส่วนเอวและป้องกันอาการปวดขณะนั่งทำงานในกลุ่มพนักงานออฟฟิศอย่างมีประสิทธิภาพ

ค่าตอบแทนที่ผู้เข้าร่วมการวิจัยจะได้รับ 150 บาท

ค่าใช้จ่ายที่ผู้เข้าร่วมการวิจัยจะต้องรับผิดชอบเอง ไม่มี

หากมีข้อมูลเพิ่มเติมทั้งด้านประโยชน์และโทษที่เกี่ยวข้องกับการวิจัยนี้ ผู้วิจัยจะแจ้งให้ทราบโดยรวดเร็วและไม่ปิดบัง

ข้อมูลส่วนตัวของผู้เข้าร่วมการวิจัย จะถูกเก็บรักษาไว้โดยไม่เปิดเผยต่อสาธารณะเป็นราย บุคคล แต่จะรายงาน ผลการวิจัยเป็นข้อมูลส่วนรวมโดยไม่สามารถระบุข้อมูลรายบุคคลได้ ข้อมูลของผู้เข้าร่วมการวิจัยเป็นรายบุคคล อาจมีคณะบุคคลบางกลุ่มเข้ามาตรวจสอบได้ เช่น ผู้ให้ทุนวิจัย สถาบัน หรือองค์กรของรัฐที่มีหน้าที่ตรวจสอบ รวมถึงคณะกรรมการ จริยธรรมการวิจัยในคนมีหน้าที่ตรวจสอบได้ โดยจะเก็บข้อมูลไว้นาน 5 ปี และระหว่างเวลาดังกล่าว จะไม่นำข้อมูลใช้ใดๆ

ผู้เข้าร่วมการวิจัยมีสิทธิ์ถอนตัวออกจากโครงการวิจัยเมื่อใดก็ได้ โดยไม่ต้องแจ้งให้ทราบล่วงหน้า และการไม่เข้าร่วมการวิจัยหรือถอนตัวออกจากโครงการวิจัยนี้ จะไม่มีผลกระทบต่อการบริการและการรักษาที่สมควรจะได้รับตาม มาตรฐานแต่ประการใด

หากท่านได้รับการปฏิบัติที่ไม่ตรงตามที่ได้ระบุไว้ในเอกสารชี้แจงนี้ ท่านสามารถแจ้งให้ประธานคณะกรรมการจริยธรรมการวิจัยในคนทราบได้ที่ สำนักงานคณะกรรมการจริยธรรมการวิจัยในมนุษย์ สถาบันยุทธศาสตร์ทางปัญญาและวิจัย อาคารศาสตราจารย์ ดร.สาโรช บัวศรี ชั้น 20 โทร (02) 649-5000 ต่อ 11019 โทรสาร: (02) 259-1822

ลงชื่อ.. ผู้เข้าร่วมโครงการวิจัย

(..)

วันที่...

คณะกรรมการจริยธรรมในมนุษย์
คณะกายภาพบำบัด มหาวิทยาลัยศรีนครินทรวิโรฒ
รหัส PTPT........ 2020-009 ....
วันที่ ...30 ก.ค. 63....... ถึง ...29 ก.ค. 64.......

Appendix F

INFORMED CONSENT FORM

หนังสือให้ความยินยอมเข้าร่วมในโครงการวิจัย

(Informed Consent Form)

วันที่ ____________________

ข้าพเจ้า____________________อายุ______ปี อยู่บ้านเลขที่______ถนน______.................
หมู่ที่______..........แขวง/ตำบล____________________เขต/อำเภอ______________..............
จังหวัด...โทรศัพท์...

ขอทำหนังสือนี้ให้ไว้ต่อหัวหน้าโครงการวิจัยเพื่อเป็นหลักฐานแสดงว่า

ข้อ 1 . ข้าพเจ้า ได้รับทราบโครงการวิจัยของ นายวิธวินท์ แซ่ลี้, ผู้ช่วยศาสตราจารย์ ดร. ภัทริยา อินทร์โท่โล่ และ ผู้ช่วยศาสตราจารย์ ดร. ณัฐพงษ์ คงประเสริฐ เรื่อง

นวัตกรรมเบาะหนุนรองนั่งเพื่อช่วยปรับท่าทางของกระดูกสันหลังส่วนเอวและกระดูกเชิงกรานในท่านั่งของกลุ่มพนักงานออฟฟิศ

ข้อ 2. ข้าพเจ้า ยินยอมเข้าร่วมโครงการวิจัยนี้ด้วยความสมัครใจ โดยมิได้มีการบังคับขู่เข็ญหลอกลวงแต่ประการใดและจะให้ความร่วมมือในการวิจัยทุกประการ

ข้อ 3. ข้าพเจ้า ได้รับการอธิบายจากผู้วิจัยเกี่ยวกับวัตถุประสงค์ของการวิจัย วิธีการวิจัย ประสิทธิภาพความปลอดภัย อาการหรืออันตรายที่อาจเกิดขึ้น รวมทั้งแนวทางป้องกัน และแก้ไข หากเกิดอันตราย ค่าตอบแทนที่จะได้รับ ค่าใช้จ่ายที่ข้าพเจ้าจะต้องรับผิดชอบจ่ายเอง โดยได้อ่านข้อความที่มีรายละเอียดอยู่ในเอกสารชี้แจงผู้เข้าร่วมโครงการวิจัยโดยตลอด อีกทั้งยังได้รับคำอธิบายและตอบข้อสงสัยจากหัวหน้าโครงการวิจัยเป็นที่เรียบร้อยแล้ว และตกลงรับผิดชอบตามคำรับรองในข้อ 5 ทุกประการ

ข้อ 4. ข้าพเจ้า ได้รับการรับรองจากผู้วิจัยว่าจะเก็บข้อมูลส่วนตัวของข้าพเจ้าเป็นความลับ จะเปิดเผยเฉพาะผลสรุปการวิจัยเท่านั้น

ข้อ 5. ข้าพเจ้า ได้รับทราบจากผู้วิจัยแล้วว่า หากมีอันตรายใด ๆ **อันเกิดขึ้นจากการวิจัยดังกล่าว** **ข้าพเจ้าจะได้รับการรักษาพยาบาลจากคณะผู้วิจัย โดยไม่คิดค่าใช้จ่ายและจะได้รับค่าชดเชยรายได้**ที่สูญเสียไปในระหว่างการรักษา พยาบาลดังกล่าว ตลอดจนมีสิทธิ์ได้รับค่าทดแทนความพิการที่อาจเกิดขึ้นจากการวิจัยตามสมควร

ข้อ 6. ข้าพเจ้า ได้รับทราบแล้วว่าข้าพเจ้ามีสิทธิ์จะบอกเลิกการร่วมโครงการวิจัยนี้ และการบอกเลิกการร่วมโครงการวิจัยจะไม่มีผลกระทบต่อการดูแลรักษาโรคที่ข้าพเจ้าจะพึงได้รับต่อไป

ข้อ 7. หากข้าพเจ้ามีข้อข้องใจเกี่ยวกับขั้นตอนของการวิจัย หรือหากเกิดผลข้างเคียงที่ไม่พึงประสงค์จากการวิจัย สามารถติดต่อกับ

- ผู้ช่วยศาสตราจารย์ ดร. ภัทริยา อินทร์โท่โล่ โทร.084-944-5859
- ผู้ช่วยศาสตราจารย์ ดร. ณัฐพงษ์ คงประเสริฐ โทร 089-200-4014
- นายวิธวินท์ แซ่ลี้ โทร. 098-925-4295

คณะกรรมการจริยธรรมในมนุษย์
คณะกายภาพบำบัด มหาวิทยาลัยศรีนครินทรวิโรฒ
รหัส PTPT .... 2020 - 009 ....
วันที่ 30 ก.ค. 63 ถึง 29 ก.ค. 64

ข้อ 8. หากข้าพเจ้า ได้รับการปฏิบัติไม่ตรงตามที่ระบุไว้ในเอกสารชี้แจงผู้เข้าร่วมการวิจัย ข้าพเจ้าจะสามารถติดต่อกับประธานคณะกรรมการจริยธรรมสำหรับการพิจารณาโครงการวิจัยที่ทำในมนุษย์หรือผู้แทน ได้ที่สถาบันยุทธศาสตร์ทางปัญญาและวิจัย มหาวิทยาลัยศรีนครินทรวิโรฒ โทรศัพท์ 02-649-5000 ต่อ 11019

ข้าพเจ้าได้อ่านและเข้าใจข้อความตามหนังสือนี้โดยตลอดแล้ว เห็นว่าถูกต้องตามเจตนาของข้าพเจ้า จึงได้ลงลายมือชื่อไว้เป็นสำคัญพร้อมกับหัวหน้าโครงการวิจัยและต่อหน้าพยาน

ลงชื่อ	ลงชื่อ ....
(..)	(..)
ผู้ยินยอม / ผู้แทนโดยชอบธรรม	ผู้ให้ข้อมูลและขอความยินยอม/หัวหน้าโครงการวิจัย
ลงชื่อ ....พยาน	ลงชื่อ ....พยาน
(..)	(..)

ในกรณีที่ผู้เข้าร่วมการวิจัย อ่านหนังสือไม่ออก ผู้ที่อ่านข้อความทั้งหมดแทนผู้เข้าร่วมการวิจัยคือ

....

จึงได้ลงลายมือชื่อไว้เป็นพยาน

ลงชื่อ ....พยาน

(..)

<u>หมายเหตุ</u>

1. ในกรณีผู้ให้ความยินยอมมีอายุไม่ครบ 18 ปีบริบูรณ์ จะต้องมีผู้ปกครองตามกฎหมายเป็นผู้ให้ความยินยอมด้วย หรือ ผู้ป่วยที่ไม่สามารถแสดงความยินยอมได้ด้วยตนเอง จะต้องมีผู้มีอำนาจทำการแทน เป็นผู้ให้ความยินยอม
2. กรณีผู้ยินยอมตนให้ทำวิจัย ไม่สามารถอ่านหนังสือได้ ให้ผู้วิจัยอ่านข้อความในหนังสือให้ความยินยอมนี้ให้แก่ผู้ยินยอมตนให้ทำวิจัยฟังจนเข้าใจแล้ว และให้ผู้ยินยอมตนให้ทำวิจัยลงนาม หรือพิมพ์ลายนิ้วหัวแม่มือรับทราบ ในการให้ความยินยอมดังกล่าวด้วย

คณะกรรมการจริยธรรมในมนุษย์
คณะกายภาพบำบัด มหาวิทยาลัยศรีนครินทรวิโรฒ
รหัส PTPT........2020-069........
วันที่....30 ก.ค. 63........ถึง....29 ก.ค. 64........

VITA

NAME	Witthawin Sae-Lee
DATE OF BIRTH	12 september 1992
PLACE OF BIRTH	Bangkok
INSTITUTIONS ATTENDED	2015 Bachelor of Science in Physical therapy from Srinakharinwirot University
HOME ADDRESS	18/147 The Metro Soi. Onnuch 80 Prawet District Bangkok 10250