

THE DEVELOPMENT OF PILLOW FOR HEALTHY PEOPLE: A PILOT STUDY

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ABSTRACT: The proper size of the pillow is an important factor in promoting the quality and quantity of sleep. However, most of the pillows available in the market are built may not be suitable to the curve of the cervical spine for Thai people. We determine the proper pillow size of 8 cm, 10 cm, and 12 cm on the perception of comfortable, the ability to produce the force of wrist flexor muscles, electromyography (EMG) signals of the upper trapezius muscle and wrist flexor muscle, and skin temperature of the neck. In addition, we studied the correlation between body height and the preferred pillow size. Thirty healthy individuals aged 20-80 years participated. The participants underwent baseline tests. After 5 minutes, the participants performed the post-tests and rated on the perception of comfortable as they rested in the supine position with their heads supported on three different heights of an adjustable pillow. Descriptive analysis, repeated-measures ANOVA, and Spearman rank tests were used to evaluate for pillow size preference. Most of the participants preferred the 8 cm pillow heights. However, most of the force and EMG of the wrist flexor muscle were greatest when they rested on the 10 cm, and 12 cm of pillow heights. EMG of the upper trapezius muscle and temperature of the neck were not statistically significant among resting on the three pillows. There was no correlation between body height and the preferred pillow size. The three pillow heights could be suitable for sleeping in healthy people.

Keywords: Pillow, Height, Comfort, Healthy

1. INTRODUCTION

In daily life, people need to sleep for at least 8 hours, which is one third in daily life. The sleep sufficiency results in a better immune system of the body [1]. After a good sleep, people can work efficiently during the day. On the other hand, insomnia or sleep insufficient can have negative effects on the body and mind such as colds, stress, other infections, metabolic syndrome, reduce the performance of work, and decision a mistake [7].

To have a good sleep proper pillow size and shapes to support the head and neck are essential. Prolonged use of improper pillow size and shape may lead to neck strain, headache, and chronic cervical spine disorders. The optimal pillow size and shape require that the sleeper feels comfortable, relaxes the neck muscles, reduces the core temperature of the body, and the cervical spine is in the neutral position during sleep. Previous studies reported that reducing the core temperature could decrease resting heart rate, provide deep sleep, and increase sleep quality [2,4,5,6]

Many materials, such as polyester, foam, feather, and latex, have been used to make pillows since they could restraint the head and neck during sleep. Proper pillows made from latex have been found to reduce neck pain, stiff neck, headache, scapula and arm pain. They could provide the feeling of comfortable sleep,

and better sleep quality when compared to pillows made from polyester, foam, and feather [2,3,4]. It was possible that when people were lying on the side on the pillows made from latex, the curvature of the cervical spine did not change much [4]. This may be due to the properties of the latex with moderate tensile strength, high elasticity, and good tear resistance.

In addition to the type of material used to make the pillows, it is important to sleep. The size, height and length of the pillows according to the cervical spine are also important for sleeping. If the pillows are not suitable for head support while sleeping, it can make the sleeper feel unwell, and neck pain. This could reflex result in the inhibition of arm muscle function [11]. Therefore, pillows with proper height, and fully support the cervical spine could help increase arm muscle strength [12].

Commonly pillows used by Thai people currently have a variety of forms such as squares, spherical discs, and wedge-shaped pillows. To prevent neck pain or help the cervical spine to be in a natural alignment, a pillow that has a convex section fitted to the curvature of the cervical spine and fully supports the head is needed. Most of the pillows available in the markets are replicated from the Western countries where curves of the cervical spine of people are different from the Thai people. Therefore, the researchers are interested in developing proper pillows to suit Thai people where physical stature,

social and cultural context are different from those in Western countries. Specifically, the purpose of this study was to evaluate the three levels pillow height on the feeling of comfort, electromyography of upper trapezius and the wrist flexor muscles of dominant limb, skin temperature of the neck while lying on the pillow, and hand grip strength. We also verify the relationship between anthropometry of the body and the pillow height that provide the most comfortable sleep.

2. METHOD

2.1 Participants

This preliminary underwent on 30 participants. They were healthy Thai people, aged between 20 -80 years old, and were randomly allocated in three different age groups of 10 20-35 years, 36-60 years, and 61-80 years, respectively. The participants were excluded if they had cervicothoracic spine injury or accident within 6 months, the dominant upper limb injury within 6 months, cervical vertigo, and muscle weakness of the dominant upper limb.

2.2 Experimental Procedure

The study was approved by the Institutional Review Board of the Khon Kaen University Ethics Committee in Human Research (HE592390). All participants provided informed consent. This study employed a cross-sectional study. All participants were asked to test the anthropometry. After that, all participants were asked to test the three-level pillow's height in the supine lying for 5 minutes/height and to select the most comfortable. Finally, all participants were asked to test the electromyography of the upper trapezius muscle and the wrist flexor muscle of the dominant upper limb, hand grip strength, and skin temperature.

2.3 Measurements

2.3.1 The anthropometry

The neck measurements were obtained with the participant's neck positioned in the neutral position while standing erect. Neck length was measured from the external occipital protuberance to the seventh cervical spinous process. Neck thickness was measured with the participant standing erect against the wall, and the length from the apex of the cervical lordosis curve to the wall was recorded. The occiput-wall distance (OWD) was measured from the seventh cervical spinous process to the wall (Fig. 1).

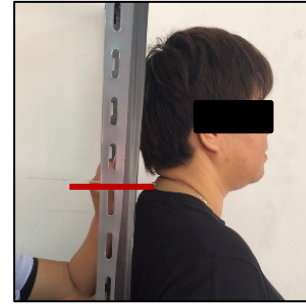


Fig.1 The occiput-wall distance (OWD) test.

2.3.2 The comfort

Measurement for comfort by using the Visual analog scale. The visual analog scale is a straight line of 10 cm. Instead, the left end represents the value 0, meaning poor comfort. The right end represents the value of 10, meaning it is a good comfort. All participants were asked to the supine lying on a pillow, three height levels as 8 cm., 10 cm., and 12 cm. for 5 minutes. After that, the participants to mark on this line to show comfort. And then bring the measured values into centimeters instead of the comfort feeling like the pain score is 0-10 (Fig.2).

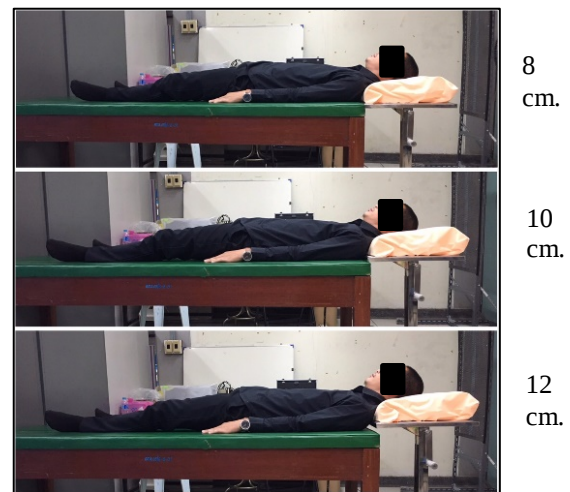


Fig. 2 A pillow, three height levels as 8 cm., 10 cm., and 12 cm.

2.3.3 The electromyography (EMG)

A researcher is attaching an electrode to the upper trapezius muscles on both sides, and the wrist flexor muscle of the dominant upper limb and allowing the participants to the supine lying on the pillows three height levels for 5 minutes/level. It repeated three times with 1-minute rest intervals between the trials. Surface EMG was measured using Cometa Wave Plus Device (Cometa®, Bareggio, Italy). The mean value of three repetitions was used for further analysis (Fig. 3).



Fig. 3 An electrode on the upper trapezius muscles both sides, and the wrist flexor muscle of dominant upper limb

2.3.4 The hand grip strength

All participants were asked to the supine lying on the pillows three-level height and measuring the force of the hand compression repeated three times with 1-minute rest intervals between the trials. The mean value of three repetitions was used for further analysis (Fig. 4).



Fig. 4 The hand grip strength test

2.3.5 The skin temperature

Measure the distribution of skin temperature every 2 minutes with the Thermograph at the neck and head while the supine lying on the pillow three-level height and record the mean of value.

2.4 Statistical Analysis

Descriptive statistics were used to determine the clinical characteristics and anthropometric measurements of the participants. The repeated-measures one-way analysis of variance (ANOVA) statistics was used to determine the effects of pillow level height on the anthropometry, comfortable, EMG, hand grip strength, and skin thermometer with

mean, standard deviation or percentage data. The Spearman Rank Correlation Coefficient statistics was used to the relationship between the anthropometry and the height of the pillow that was most comfortable, statistically significant at the 0.05 level. The statistical analysis using SPSS version 17.

3. RESULT

Thirty individuals participated in the study. The demographic and clinical characteristics of the participants are presented in Table 1.

Table 1 Demographics and anthropometric measurements of the participants.

	20-35 (y)	36-60 (y)	61-80 (y)
Age (y)	26±3.7	45±7.9	69.9±5.3
Sex (M/F)	3:7	3:7	0:10
Body length (m)	1.6±0.1	1.6±0.1	1.5±0.1
Body weight (kg)	65.1±18.1	66.2±11.2	56.09±5.5
BMI (kg/m ²)	24.3±5.1	25.7±2.9	23.5±2.6
Neck length (cm)	10.8±1.3	10.6±1.6	8.9±1.1
Neck thickness (cm)	6.6±1.3	7.2±1.1	6.9±1.4
OWD (cm)	5.2±1.5	5.4±1.8	5.3±1.5

Data are presented as n or mean ± standard deviation. BMI = body mass index; F = female; M = male. The occiput-wall distance = OWD

3.1 The Effectiveness of Health Pillows for Thai People Aged 20-80 Years

3.1.1 Age 20-35 years group

The comfort, the EMG of the upper trapezius muscle and the wrist flexor muscle of the dominant upper limb, the hand grip strength, and the skin temperature were not significantly different between the three pillows' height ($p > 0.05$) in Fig. 5 and Table 2.

3.1.2 Age 36-60 years group

The pillow height at 8 cm. that the most comfortable ($p < 0.05$) in Fig. 5. On the other hand, the EMG of the upper trapezius muscle and the wrist flexor muscle of the dominant upper limb, the hand grip strength, and the skin temperature were not significantly different between the three pillow's height ($p > 0.05$) in Table 2.

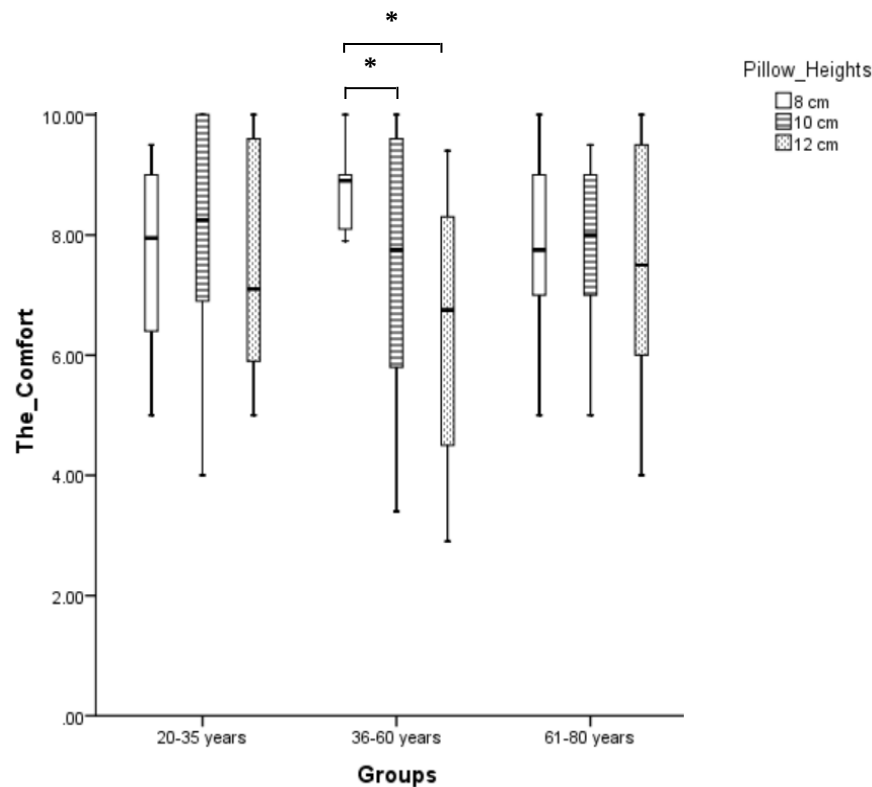


Fig. 5 The comfort on three different heights of pillow

3.1.3 Age 61-80 years group

The comfort, the EMG of the upper trapezius muscle and the wrist flexor muscle of the dominant upper limb, the hand grip strength, and the skin temperature were not significantly different between the three pillow's height ($p > 0.05$) in Fig. 5 and Table 2.

3.2 The Relationship between the Anthropometry and the Height of the Pillow That the Most Comfortable

The height of the most comfortable pillow in the age of 20-35 years group was 10 cm, while the age of 36-60 years group and age of 61-80 years group were 8 cm. However, the three age groups had no relationship between the anthropometry (neck length, neck thickness, and occipital to the wall) and the height of the pillow that was most comfortable ($p > 0.05$) in Table 3.

4. DISCUSSION

This research aims to study and develop health pillows for Thai people with a physical structure and Thai social and cultural context. The objectives are to test the health pillows for three-level heights on the

comfortable, EMG, hand grip strength, skin temperature. In addition to studying the relationship between the anthropometry and the pillow height that the most comfortable.

4.1 The Pillow Heights on the Comfortable

The height level of pillows that the participants feel the most comfortable as 8 centimeters, which was consistent with Wang JC et al [12]. They conducted by allowing participants to the supine lying on 11 pillows of different height, and then choose the pillow that feels the most comfortable. They found a pillow height at 8 cm. the participants feel the most comfortable. Inconsistent with Sacco IC et al [9], they study the participants to lying on three pillow height as 5 cm. 10 cm. and 14 cm. they measure the comfortable while lying on the pillow for 5 min/pillow height. They found the participants lying on a pillow height 10 cm. feel the most comfortable when comparing the height of the other two pillows. The length of the cervical spine of the participants tends to decrease as they age. The pillow with a height of 8 cm. was the height that can be recommended for Thai people to sleep for health.

4.2 The Pillow Heights on EMG

The EMG of the upper trapezius muscle and the wrist flexor muscle of the dominant upper limb were

Table 2 The Effectiveness of Health Pillows for Thai People Aged 20-80 Years.

	Group (y)								
	20-35			36-60			61-80		
The pillow height (cm)	8	10	12	8	10	12	8	10	12
Comfort (cm)	7.73 ±1.42	7.81 ±2.16	7.44 ±1.84	8.41 ±1.68*	7.44 ±2.41	6.26 ±2.42	7.61 ±1.71	7.60 ±1.63	7.45 ±2.06
EMG of Rt. upper trapezius m. (μV)	2.20 ±0.63	2.20 ±0.42	2.20 ±0.63	2.10 ±0.31	2.40 ±0.70	2.00 ±0.00	2.20 ±0.42	2.30 ±0.48	2.30 ±0.68
EMG of Lt. upper trapezius m. (μV)	3.00 ±0.67	3.00 ±0.67	2.90 ±0.99	3.20 ±1.48	3.80 ±1.03	3.50 ±0.71	3.50 ±1.65	3.80 ±1.03	3.50 ±1.72
EMG of wrist flexor m. (μV)	74.60 ±30.02	68.30 ±20.87	73.80 ±30.20	63.70 ±20.02	67.90 ±16.31	63.70 ±18.67	69.20 ±26.14	66.30 ±26.12	62.70 ±20.48
Forces of wrist flexor m. (kg)	26.05 ±10.45	24.99 ±8.01	25.42 ±11.17	27.91 ±8.76	28.77 ±8.37	26.34 ±9.67	20.72 ±3.46	21.18 ±4.09	20.88 ±3.96
Skin temp.(°c)	35.11 ±0.97	34.94 ±0.88	35.19 ±0.70	34.92 ±0.87	34.84 ±0.84	34.82 ±0.80	33.82 ±1.24	34.4 ±1.10	34.56 ±1.03

Data are presented as n or mean ± standard deviation.

* Significant differences between the pillows as p value < 0.05

not different between the three pillows height, which is consistent with Sacco IC et al [9]. They studied the EMG signal of the sternocleidomastoid muscle and upper trapezius muscle; the EMG was not significantly between lying on the three pillow's height. However, Sacco IC et al [9] found that the EMG of the middle trapezius muscle was the least when lying on the pillow in the pillow height that feels most comfortable and the most valuable when lying on the pillow height that feels the least comfortable. On the other hand, Wang JC et al [12] found that the pillows that the most comfortable had the highest EMG signal in wrist extensor muscle. However, in this study the participants in 61-80 years group had an EMG signal of the wrist flexor muscle tends increasingly in the pillow height level that the most comfortable.

4.3 The Pillow Heights on the Hand Grip Strength

The pillow height is effect by the cervical spine causing it too uncomfortable and resulting in reflex-type muscle inhibition of the upper extremity. Inhibition is frequently in muscles that cross the joints

owing to joint pathology [8]. However, previous studies demonstrated that muscle inhibition due to spinal dysfunction can occur in muscle groups that are not directly connected to the spine. Suboptimal cervical alignment due to an uncomfortable pillow may produce sensory inputs and therefore affect the normal function to muscles of the upper extremity [10,11]. In this study, muscle forces of the hand grip strength were not different between the pillow heights. Inconsistent with Wang JC et al [12] found that the pillows that the most comfortable had the highest forces in wrist extensor muscle. Due to this study had a small sample size, it may be observed the difference of wrist flexor muscle forces between the pillow heights.

4.4 The Pillow Heights on the Skin Temperature

The skin temperature of the three pillows' height was not different. Which is not consistent with Jeon et al. [6] that found that proper pillow must reduce the temperature of the head or body core temperature, causing the heart rate to slow down and sleep deeper. Due to this study ask the participants to lie 5 minutes/pillow height, it may be that period is not

enough to relaxation and the heart rate slows down. Therefore, it did not affect the temperature reduction of the head while lying on the most comfortable pillow.

Table 3 The relationship between the anthropometry and the height of the pillow that the most comfortable.

Group (y)	Anthropometry	The height of the most comfortable pillow	
		r_s	p-value
20-35	Neck length	-0.17	0.64
	Neck thickness	0.42	0.23
	The occiput-wall distance	-0.01	0.97
36-60	Neck length	0.14	0.71
	Neck thickness	-0.18	0.61
	The occiput-wall distance	0.06	0.87
61-80	Neck length	0.33	0.36
	Neck thickness	-0.03	0.93
	The occiput-wall distance	0.20	0.57

r_s = Spearman Rank Correlation Coefficient.

* Significant differences between the pillows at p value < 0.05

4.5 The Relationship between the Anthropometry and the Pillow Height That the Most Comfortable

The three age groups had no relationship between the anthropometry (neck length, neck thickness, and occipital to the wall) and the height of the pillow that was most comfortable. It corresponds to Wang JC et al [12], which allows the participants to lie on 11 pillows of varying height and choose the pillows that feel the most comfortable. They found that the anthropometry had a relationship with the most comfortable pillow. However, this study found that the anthropometry was not related to the pillow that feels comfortable.

5. CONCLUSIONS

According to the results of this study, we concluded that the pillow height at 8 cm could provide the most comfortable for sleeping in the age 36-60 years group. Whereas the age 20-35 years and 61-80 years were not shown the significant difference of comfortable feeling and the high pillow's levels. However, our study had no relationship between the

anthropometry and comfortable pillows at each pillow high. For the future, we would like to suggest an investigation of larger samples, various sleep duration, or disease conditions (such as insomnia, neck pain, etc.) to get a clearer answer.

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7. REFERENCES

- [1] Brice F., Karim B., Vanhamme Z.L. and Myriam K., Immune, inflammatory and cardiovascular consequences of sleep restriction and recovery, *Sleep Medicine Reviews*, Vol. 16, Issue 2, 2012, pp. 137-149.
- [2] Susan G.J., Karen G.S. and Patricia T., Pillow use: The behavior of cervical pain, sleep quality and pillow comfort in side sleepers. *Manual Therapy*, Vol. 14, Issue 6, 2009, pp. 671-678.
- [3] Susan G.J., Karen A., Grimmer-Somers and Patricia H.T., Pillow use: the behavior of cervical stiffness, headache and scapular/arm pain. *Journal of Pain Research*. Vol. 3, 2010, pp. 137-145.
- [4] Susan G.J., Karen A., Grimmer-Somers and Patricia H. T., A randomized, comparative trial: does pillow type alter cervicothoracic spinal posture when side lying?. *Journal of Multidisciplinary Healthcare*, Vol. 4, 2011, pp. 321-327.
- [5] Susan G.J. and Grimmer-Somers K., Your Pillow May Not Guarantee a Good Night's Sleep or Symptom-Free Waking. *Physiotherapy Canada; SPR*, Vol. 63, Issue 2, 2011, pp. 183-190.
- [6] Jeon M.Y., Jeong H., Lee S.W., Choi W., Park J.H., Tak S.J., Choi D.H. and Yim J., Improving the Quality of Sleep with an Optimal Pillow: A Randomized, Comparative Study. *Tohoku Journal Of Experimental Medicine*, Vol. 233, Issue 3, 2014, pp. 183-188.
- [7] Simon K.D., Kevin M. and Colin E.A., Insomnia and health-related quality of life. *Sleep Medicine Reviews*, Vol. 14, Issue 1, 2010, pp. 69-82.
- [8] Rice D.A. and McNair P.J., Quadriceps arthrogenic muscle inhibition: neural mechanisms and treatment perspectives. *Seminars in Arthritis and Rheumatism*, Vol. 40, Issue 3, 2010, pp. 250-266.
- [9] Sacco I.C., Pereira IL, Dinato R.C., Silva V.C., Friso B. and Viterbo S.F., The Effect of Pillow

- Height on Muscle Activity of The Neck and Mid-Upper Back and Patient Perception of Comfort. *Journal of Manipulative & Physiological Therapeutics*. Vol. 38, Issue 6, 2015, pp. 375-381.
- [10] Suter E. and Lindsay D., Back muscle fatigability is associated with knee extensor inhibition in subjects with low back pain. *Spine*, Vol. 26, Issue 16, 2001, pp. 361-366.
- [11] Suter E. and McMorland G. Decrease in elbow flexor inhibition after cervical spine manipulation in patients with chronic neck pain. *Clinical Biomechanics*, Vol. 17, Issue 7, 2002, pp. 541-544.
- [12] Jia-Chi W., Rai-Chi C., Han-Lin W. and Chih-Jou L., Effect of pillow size preference on extensor digitorum communis muscle strength and electromyographic activity during maximal contraction in healthy individuals: A pilot study. *Journal of the Chinese Medical Association*, Vol. 78, Issue 3, 2015, pp. 182-187.

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