



Cervical pillow height measurement- A literature review

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Abstract

Background: Cervical pillow is an important part of the sleep system, which is optimal to support our head weight and neck. It will help helps to maintain physiological curvature of the cervical spine, support the head weight, relaxes the neck muscle, correct the spine alignment, and reduces the pressure over the intervertebral disk between cervical spines.

Aims and objectives: Objective is to review the various methods of cervical pillow height measurement.

methodology: Searching the articles using various search engines such as Google, Google scholar, PubMed, Ovid, Cochrane, EBSCO discovery etc. Searched articles were appraised using appraisal tool. All types of studies like systemic review, randomized control trails, cohort studies and experimental studies were included. Articles related to cervical pillow, importance of ideal pillow height, current measures available to measure the cervical pillow height were included

Results and conclusion: The current review of literature emphasizes a new prototype Preparation for cervical pillow height measurement is necessity.

Keywords: Cervical pillow, height measurement, cervical alignment, quality of sleep, importance of cervical pillow and pillow height.

Introduction

Cervical pillow is an important part of the sleep system, which is optimal to support our head weight and neck. It will help helps to maintain physiological curvature of the cervical spine, support the head weight, relaxes the neck muscle, correct the spine alignment, and reduces the pressure over the intervertebral disk between cervical spines.

Pillow height is one of the crucial parameter of pillow which is related to cervical spine alignment and the mechanical environment of the cervical spine. So while selecting appropriate pillow height in addition to subjective evaluation (age, gender, and sleeping habits and perception), it has also been shown to affect cervical spine alignment, muscle activity and distribution of pressure in the cervical and cranial region^[4]

An appropriate pillow height promotes better alignment of the head, neck, shoulder, and also symmetry between two sides of body, which can reduces muscle activity, promote the quality of sleep^[8]. Sleep issues are now considered as a severe problem that can harm both mental and physical health. Sleep play important role in immunity improvement, mental and physical health also in memory power. Changing pillows can significantly cause cervical pain, scapular pain, head ache, and cervicothoracic symptoms. Everyone have their own habitual posture during the sleep, supine and lateral positions are common (prone position is rare). Sleep is dynamic process during which individual change their position unconsciously approximately 24 times to avoid fatigue, mainly between supine and lateral positions⁵. Sleeping posture is a significant concern; it can improve our quality of sleep, which is mainly determined by cervical pillow height which maintain the cervical spine and by providing adequate support for head weight and neck

complex. Sleep posture affect the heart functions, diastolic, systolic, and mean arterial blood pressure are lower in the lateral position than the supine posture. And our sleep posture affects our breathing process, supine positions will likely to cause asphyxia and sleep apnea than the lateral positions. Lateral position reduces the airway collapse and improves airway expansion, which will help to inhibit the occurrence of sleep apnea^[6]. Sleep posture influence the spine alignment by producing different trunk angles. The ideal physiological spine curvature can promote sleep by reducing the stress inside the cervical spine and relaxes the back and neck muscle^[7].

Currently available measures for the height of pillow with cervical spine alignment and body dimension, among the most important is measuring the “four morphological parameters of cervicothoracic spine” segments using three pillow heights with radiographs, [including neck tilt, T1 slope, thoracic inlet angle, and C2-7 Cobb’s angle]^[9].” Finite element analysis” is another method commonly used, by building a different finite element models based on the head and neck^[10]. The Cervical angle, lordosis and kyphosis distance were three factors for the alignment of the cervical spine. A "whole-body 3D laser scanner" was used by Huang and Alice to gauge the width of the head, half the length of the shoulder, and the distance from the external occipital protuberance to C7^[11]. The breadth from the ear to the shoulder (height supporting the head in lateral posture), the length from the hindbrain to the wall (height supporting the head in supine position), and the length from the neck to the wall (height supporting the neck in supine position) were the important characteristics. Other method is “American TEKscan body pressure measurement system (BPMS)” was used to measure the pressure distribution of the head, cervical region, chest, back, waist, and hip¹². The muscle

activity measurement system- circular electrodes were placed on the muscles of the neck and shoulder (extensor digitorum communis muscle, sternocleidomastoid, upper trapezius, and middle trapezius), and an EMG was used to measure the muscle activity. In addition, the muscle strength of the upper extremity muscles was also measured [13]. The height of pillow directly proportional to the T1 slope and C2-7 Cobb's angle, means a pillow that is too high can cause the cervical spine to bend forward, if pillow that is too low can cause the cervical spine to extend rearward. So we should select a cervical pillow with optimal height based on individual characteristics and parameters. "Therefore the main objective of this study is to review the various methods of cervical pillow height measurement".

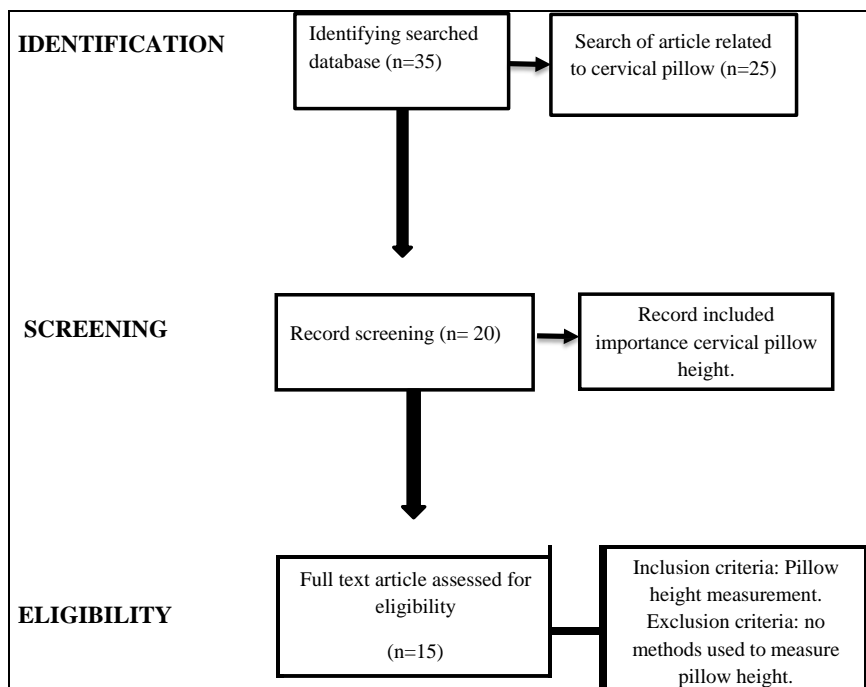
Methods

This is a review of literature pertaining to importance of cervical pillow height measurement. Various search engines were used for searching literature related pillows. The criteria for inclusion of articles is to identify the commonly used assessment tools for cervical pillow with

ideal height and its importance in the sleep system. Articles related to cervical pillow, importance of ideal pillow height, current measures available to identify height of cervical pillow were included. Search engines using Google scholar, PubMed, EMBASE, MEDLINE, CINAHL, Ovid, SAGE, Springer link, Science direct, EBSCO discovery service etc. and whatever possible hand search articles was done on the university library and research Centre. Also, the search period did not have an end date. Those articles which were published in English language, irrespective of the year of their publication were included in this study.

Articles were selected on the basis of inclusion criteria. The selected articles are appraised using a specific appraisal tool depending on the type of articles. After appraisal the articles are included for the review on the basis criteria of appraisal selection.

By using above search engines, we got 25 articles related to the cervical pillow. Out of these, 20 articles were focusing on height of cervical pillow. The present review includes a total of 15 publications after further filtering in accordance with the inclusion and exclusion criteria.



Results

1. Robert A Lavin and Macro Pappagallo et al in 1997 conducted a study on cervical pain: A comparison of three pillows-Randomized crossover design study. The current study compares three pillows for people with benign cervical discomfort in terms of pain alleviation, sleep quality, disability, and overall happiness. The three pillows are used to evaluate subjects, which include a usual pillow, water based pill and roll pillow. 46 subjects with neck pain recruited through newspaper advertisement. People with history of dementia, neoplasm, and known infection in the cervical region were excluded. The study is mainly focused on 3 pillows, were all the subject is instructed to sleep using each pillow for 2 weeks. The Visual Analogue Scale (VAS), the Sleep Questionnaire, the Sickness Impact Profile (SIP), and the Satisfaction Scale Rating of the Pillows are used as outcome measures. They came to the conclusion that while proper pillow selection can

greatly reduce pain and enhance sleep quality, it has little to no impact on the SIP's assessment of impairment outcomes.

(Remark of the study -they compared the effect of 3 pillows which are Customized pillows, not based on body dimensions).

2. Parham Erfanian et al in 2004 conducted study on Assessing effect of semi-customized experimental cervical pillow on symptomatic adults with chronic neck pain with and without headache-A Randomized controlled trail. A semi-customized experimental cervical pillow was used in this study to see if it might affect adults with symptomatic chronic neck pain. The study enrolled 36 adults (>25 years) with chronic neck discomfort. A cervical pillow prototype with foam quadrant of increasing height was administered. Self-report questionnaire with 11 point numerical rating pain scale (NRS) to collect the primary outcome measures of pre and post sleep neck pain was used. And also

- completed CMCC neck disability index (NDI) once per week.
(Remarks of the study- Uneven consistency of height of pillow is used and the measurement method is not similar to my study)
3. Susan J Gordon, Karen A Grimmer-somers et al in 2010 conducted study on Pillow use: the behavior of cervical stiffness, headache and scapular/arm pain- A Randomized controlled trial. Healthy adults over the age of 18, who often slept on each side with just one pillow. The study excludes participants who receive medical treatment for cervicothoracic spine complaints, use more than two pillows, and report having experienced trauma or an illness that affects the cervicothoracic spine in the year prior. The study included trail pillows (feather, ordinary foam, standard dunlopillo latex, and polyester) ranging in height from 115 to 142 mm, width from 45 to 46 cm, and length from 70 to 73 cm. With freshly created cumulative waking symptoms scores for each pillow, the study analysis is completed. Additionally, ANOVA models were employed to examine the importance of the influence of trail pillows. (Remarks of the study- The study is done with customized pillows having different materials and same height. Customized pillow heights for individual's cervical parameters are not included and the measurement method is not similar to my study).
 4. Shuo-fang Liu and Yann-long Lee et al in 2011 conducted study on Shape design of an optimal comfortable pillow based on the analytic hierarchy process method- Experimental study. The aim of this study was to examine the connection between asymptomatic patients' subjective comfort level and the pillow form design. 30 asymptomatic subjects included in the study with providing questionnaire including information to height, sex, weight, age, and sleep posture. Those with back problems were excluded from the study. 4 basic pillows design are selected and recombined to 8 configurations to testing the degree of comfort level. Subject is asked to lie on each pillow for 1 minute and comparing the comfort level between each, including head comfort, neck comfort, shoulder comfort, height comfort, and overall comfort. The results is analyzed through the photographs and questionnaires.
(Remarks of the study- the study is done by customized 4 pillows with 8 different configuration, based on the results prototype pillow was developed. The pillows are not customized based on the individual cervical parameters and measurement method is not similar to my study).
 5. Usan J Gordon and Karen A Grimmer et al in 2011 conducted a study on Does pillow type alter cervico-thoracic spinal posture when side lying. A Randomized, comparative study. The study's goal is to determine how various pillow materials and shapes affect the slope of the cervico-thoracic spine segments when a person is resting on their side. Over-18-year-old side sleepers were recruited for the study. The study excludes participants who have undergone cervico-thoracic spine surgery, have sustained a cervico-thoracic spine injury, or are currently receiving therapy for neck pain. Each participant is instructed to lie down on a regular-shaped polyester, foam, feather, latex, and contour-shaped foam pillow for 10 minutes. Reflective markers were positioned at C2, C4, C7, and T3 on the external occipital protuberance (EOP). At the beginning and conclusion of the trial, a digital photograph was taken. Significant variations in EOP were found by the ANOVA models at C2, C4. (Remarks of the study- the study used to compare the cervico-thoracic spinal segment slope in pillows having different materials. Customised pillow heights are not used. Only cervico-thoracic slope is considered in the study, other parameters are not. Measurement method is not similar to my study).
 6. Hsiao-Lin Chen and Dengchuan Cai et al in 2012 conducted a study on Body dimension measurement for pillow design for Taiwanese- Analytical study. The study aims to determine the pillow dimensions which is fitting for supine and lateral positions for Taiwanese. 20 students (10 males and 10 females) having age of 20-28 years, height of 150-180cm and weight of 45-75kg were included in the study. Martins' anthropometric measuring tool, which includes a stature gauge, beam callipers, sliding callipers, outside callipers, tape measure, and ruler, is used to measure body proportions. And second instrument is body-curve measurer.
(Remarks of the study- Customised pillow height used in the study is not similar to my study).
 7. Jia-chi wang and Rai-chi chan et al in 2014 conducted a study on Effect of pillow size preference on extensor digitorum communis muscle strength and electromyographic activity during maximal contraction in healthy individuals A pilot study. This study's goal was to ascertain the impact of preferred pillow size on maximal voluntary contraction and Exercise of the extensor digitorum communis (EDC) muscle using electromyography (EMG). The study includes 29 healthy participants between the ages of 24-55. People with cervicogenic headaches and dizziness, musculoskeletal disorders of the dominant upper limb, and those who are currently receiving therapy for cervicothoracic spine discomfort are excluded from the study. In the study, 11 cervical pillows with the same filling but varying heights and widths of 6 to 12 cm and 31 to 34 cm were employed. Body mass index (BMI), neck length, and neck width were factors in the initial evaluation. Standing upright, the neck is measured from the seventh cervical spinous process to the external occipital protuberance. Extensor digitorum communis function involves employing.
(Remarks of the study- the study is comparing the muscle contraction and EMG amplitude on already pillows having different height. Not customizing pillow height for individual cervical parameters and measurement method is not similar to my study).
 8. Mi Yang Jeon et al in, 2014 conducted a study on Improving the quality of sleep with an optimal pillow. A Randomized, comparative study. The study's goal was to examine the impact of various cushion features on cervical curve, pillow temperature, and pillow comfort. A feather pillow is regarded as a standard pillow, and a memory foam pillow is one of the most popular pillows among pillow users. 20 healthy subjects (10 males and 10 females) having age range of 21-30

- years are included in the study. Subject with neurological disorders, scoliosis, inflammatory or degenerative arthropathy, connective tissue disease, or history of spinal surgery were excluded from the study. 3 pillows were tested, Orthopedic rolled pillow (50 cm length, 45cm width, 4-8cm in depth), memory foam pillow (50cm length, 38 cm width and 6- 10cm in depth) and feather pillow (60cm length, 45cm in width, and Lateral radiographs of the cervical spine in supine position to measure the Cobb angle between C2 and C7. Variations in the pillow temperature by infrared thermometer and measure of comfort by visual analogue scale (VAS). (Remarks of the study- the measurement method is not similar to my study and study is done with already made 3 pillows having different parameters. Customized pillows having different height for individual cranio cervical parameters are not considered).
9. Hyung cheol kim and Hyo sub et al in Jun 2015 conducted a study on The effect of different pillow height on the parameters of cervicothoracic spine segments. Cohort study. The purpose is to look at how different pillow heights affect the slope of the segments of the cervicothoracic spine. The study comprised 16 asymptomatic people between the ages of 20 and 30. People who have undergone cervicothoracic spine surgery, had an accident that injured their spine, or received treatment for neck issues are not eligible. The study is conducted in a supine position with three different pillow heights (0 cm, 10 cm, and 20 cm). The radiograph is used to measure the Thoracic inlet angle (TIA), T1 Slope, Neck tilt (NT), and C2-7 Cobb's angle, which are all cervical sagittal parameters. utilizing correlation coefficient for statistical analysis. Three different-height pre-made pillows are used in the study. They came to the conclusion that the cervical parameter was the most appropriate. (Remarks of the study- the pillow height is not customized based on the measured body dimensions).
 10. Sicong Ren, Duo Wai –Chi wong and Hui Yang. et al in 2016 conducted a study on Effect of pillow height on biomechanics of the head-neck complex: investigation of the cranio- cervical pressure and cervical spine alignment. Observational study the objective of the present study was to evaluate the influence of pillow heights on the biomechanics of the head- neck complex. It was hypothesized that pillow height would alter the cervico-cranial pressure and alignment. 10 healthy subjects (5 males and 5 females) with mean age of 26-29 years are recruited. The subjects reported no history of chronic myofascial pain, acute injury, or infection of spine. The average neck length of patients are 12.9(+/- 1.2) cm. The Neck length was the distance between the inion and the spinous process of C7, which is measured in upright standing posture. The subject lay on pillows of 4 different heights (110, 130, 150 and 170 mm). Pressure sensitive mat is used to measure the pressure distribution on the pillow. (Remarks of the study- the study is done with already customized pillows having 4 different heights. The importance is given to craniocervical pressure. They are concluded that, pillow height elevation significantly increased the pressure of cranial and cervical region. The pillow height is not customized based on the measured body dimensions).
 11. Jae Hwan Lee, Joon-Shik shin and Hankeel Yoo et al in 2016 conducted a study on Short- term effect of a functional cervical pillow on in patients with neck discomfort. A randomized controlled trail. The purpose of this study was to compare the effects of a functional cervical pillow designed to support the cervical alignment and balance in both supine and side-sleeping positions with a general pillow in inpatients with neck discomfort. 60 participants aged 18-69 years hospitalized for musculoskeletal disease, especially neck pain are included in the study. Severe neck pain such as tumour, fracture, infections, inflammatory spondylitis, cauda equina syndrome and spondylolisthesis were excluded from the study. The size of the selected functional cervical pillow was 650*350*180mm with occipital base support, 2 core, cervical support structure, and 2 side flaps. Head forward posture measured through c-spine Xrays. Included outcome measures are visual analogue scale (VAS), 5-Point likert scale, Pittsburgh sleep quality index and EQ-5D questionnaire. (Remarks of the study- the study is done to compare general pillow with functional cervical pillow. Customised pillows are not used and cranio-cervical parameters are not considered).
 12. Myeong Ryeol Kim, Joo Young Chung et al in 2016 conducted a study on The influence of pillow material and shape on cervical curvature stability. Observational study. This study aims to provide basic materials for selecting an appropriate type of pillow that will maintain the cervical spine to be in a neutral position during sleeping time. 28 participants (14 males and 14 females) were selected in the study. The subjects taking medical management for the neck pain, scoliosis, inflammatory or degenerative arthritis and connective tissue diseases and neck surgery were excluded from the study. Total 3 types of pillows are used in the study, foam pillow (60cm length, 45cm width and 17cm in height), memory foam pillow (50cm in length, 38cm width and 5-7cm in A three –dimensional analyser was used to measure supportive capacity of cervical spine. 6 cameras used for recording and infrared light reflected by spherical passive markers were used. (Remarks of the study- the study is comparing supportive capacity of cervical spine using customized 3 different pillows. The measurement method is not similar to my study, and customized pillow heights for individuals based on cervical parameters are not considered).
 13. MinHyeok Choi, Jin-Hwa jung et al in 2018 conducted a study on Effect of a cervical support pillow on sternocleidomastoid activity and satisfaction in asymptomatic participants. Cross over study design. The aim of this study was to examine the changes in sternocleidomastoid muscle (SCM) activity when using a cervical support pillow (CSP) and to determine the pillow's effect on satisfaction in asymptomatic participants. 20 asymptomatic subject (12 females and 8 males) having age of 25-30 years and BMI of 20-24 were included.
 14. Participants having sleep problems, neck pain and history of spinal surgery were excluded from the study. Participants were placed in supine position for 5 minute

in each pillow (general and cervical support pillow). The activity of sternocleidomastoid was analysed using surface electromyography and visual analogue satisfaction scale (VASS) was used to evaluate the subject satisfaction after use of each pillows.

(Remarks of the study- customized pillows are not used and measurement method is not similar to my study. Study is focused on the activity of SCM and no relation with different heights of pillows).

15. Yu Li, Jianfeng Wu et al in 2021 conducted a study on Pillow support model with partitioned matching based on body pressure distribution. Experimental study. The purpose of this research was to construct an ideal pressure distribution model for head and neck support through research on the partitioned support surface of a pillow in order to guide the development of ergonomic pillows. Six healthy subjects (3 male and 3 female) with normal cervical curvature are recruited. Subjects are relatively close, age of 23-27. After comparing the 32 pillows, 7 memory foam ergonomic pillows with the highest user reviews were selected as samples. Pillows having heights of 60-120mm, width of 300-400, and length ranging from 500- 600mm. Ensure participants are relaxed during the procedure. Using electromyography the captivity of upper trapezius and sternocleidomastoid are recorded. After that subjects were asked to fill the experience form to evaluate the comfort out of seven pillows in the two sleeping positions (supine and lateral). For constructing ideal model to support head and neck occipital body pressure distribution index is calculated.

(Remarks of the study- the study is mainly focused on muscle activity and body pressure distribution. Pillows are not Customized based on the cervical parameters and needs of individual subjects).

16. JiaXing Lei And Peng-Fei Yang et al in 2021 conducted a study on Ergonomic consideration in pillow height determinants and evaluation. Literature review. The aim of the review is measurement methods and determinants used to evaluate pillow height based on the effects of the physiological and mechanical characteristics of the head-neck-shoulder complex. most of the articles focused on pillow materials (foam pillow is common) and shape. Two studies designed a pillow that can maintain a normal head and neck by measuring body dimensions (U shaped pillow) and also two studies used a typical B shaped pillow which can support the cervical spine. Among reviewed articles, the measurement is mainly taken using radiographs, and Finite alignment analysis is another method.

(Remarks of the study- using predicted cervical spine alignment, under 4 pillow heights constructed a finite element model for head and neck).

Discussion

A cervical pillow is a crucial component of a restful night's sleep. One third of a person's life is spent sleeping, and getting enough restful sleep can help with everyday physical and mental exhaustion, restoring the balance of your body's metabolic processes, reducing accumulated fatigue, and regenerating nerve cells. And, the height of the pillow is a crucial component of the perfect pillow because it helps to

align the head, neck, shoulder, and body's two halves more comfortably.

The study is done with the purpose of reviewing literature of cervical pillow height measurement. Searching the articles using various search engines such as Google, Google scholar, PubMed, Ovid, Cochrane, EBSCO discovery etc., with the key words cervical pillow, height measurement, cervical alignment, quality of sleep, importance of cervical pillow and its height.

The criteria for inclusion of articles are commonly used assessment tools for ideal cervical pillow height and its importance in the sleep system. Articles related to cervical pillow, importance of ideal pillow height, current measures available to measure the cervical pillow height were included and 15 full text articles assessed for the eligibility. 15 articles are reviewed with the purpose of understanding the current measurement available to measure the cervical pillow, importance of cervical pillow and to identify the lacunae of the study.

The methods used to measure are following,

1. Radiographs (x rays) of C-spine are taken for measuring the head forward posture.
2. Thoracic inlet angle (TIA), Neck tilt and Cobb's angle between C2-7 from radiographs of cervical spine during supine lying.
3. Electromyography: Subject are relaxed during the procedure and electromyography of sternocleidomastoid and trapezius muscle.
4. Visual analogue satisfaction scale (VASS) is used evaluate the subject satisfaction while using each pillows.
5. A three dimensional analyzer for measuring supportive capacity of cervical spine.
6. Neck length: Distance between inion and spinous process in erect standing posture. Pressure sensitive mat is used for measuring the distribution of pressure over pillow.
7. Finite element analysis model of cervical pillow.
8. Infrared thermometer for measuring the variations of pillow temperature.
9. (VAS) visual analogue scale.
10. Purpose built dynamometer for height of pillow on maximal contraction force.
11. Reflective marker.
12. Digital image.
13. Already customized pillows having different height.
14. Sickness impact profile (SIP).

All the methods mentioned above are varying in procedure and expensive in nature. A definite 2 or 3 dimensional pillow height measurer equipment is need for the patients. Thus considering review of literature the necessity of preparing equipment for cervical pillow height measurement.

Limitations of the study

The study included only review between 1997 and 2021 which have English origin. Technical and engineering background studies are yet to be done.

Future of the study

It is necessary to do a thorough technical analysis.

Conclusion

The current review of literature emphasizes a new prototype preparation for cervical pillow height measurement is necessity.

References

1. Di Cagno A, Minganti C, Quaranta F, Pistone EM, Fagnani F, Fiorilli G, Giombini. Effectiveness of a new cervical pillow on pain and sleep quality in recreational athletes with chronic mechanical neck pain: A preliminary comparative study. *J Sports Med Phys Fitness*,2017;57:1154–1161. [CrossRef]
2. Her JG, Ko DH, Woo JH, Choi YE. Development and comparative evaluation of new shapes of pillows. *J Phys Ther Sci*,2014;26:377–380. [CrossRef]
3. Chun-Yiu JP, Man-Ha ST, Chak-Lun AF. The effects of pillow designs on neck pain, waking symptoms, neck disability, sleep quality and spinal alignment in adults: A systematic review and meta-analysis. *Clin Biomech*,2021;85:105353. [CrossRef]
4. Radwan A, Ashton N, Gates T, Kilmer A, VanFleet M. Effect of different pillow designs on promoting sleep comfort, quality, & spinal alignment: A systematic review. *Eur J Integr Med*,2021;42. [CrossRef]
5. Cai D, Chen H-L. Ergonomic approach for pillow concept design. *Appl Ergon*,2016;52:142–150. [CrossRef] [PubMed]
6. Oksenberg A, Khamaysi I, Silverberg DS, Tarasiuk A. Association of body position with severity of apneic events in patients with severe nonpositional obstructive sleep apnea. *Chest*,2000;118:1018–1024. [CrossRef]
7. Wong DW, Wang Y, Lin J, Tan Q, Chen TL, Zhang M. Sleeping mattress determinants and evaluation: A biomechanical review and critique. *PeerJ*,2019;7:e6364. [CrossRef] [PubMed]
8. Sacco IC, Pereira IL, Dinato RC, Silva VC, Friso B, Viterbo SF. The effect of pillow height on muscle activity of the neck and mid-upper back and patient perception of comfort. *J Manip Physiol Ther*,2015;38:375–381. [CrossRef]
9. Kim HC, Jun HS, Kim JH, Ahn JH, Chang IB, Song JH, *et al.* The Effect of Different Pillow Heights on the Parameters of Cervicothoracic Spine Segments. *Korean J Spine*,2015;12:135–138. [CrossRef]
10. Ren S, Wong DW, Yang H, Zhou Y, Lin J, Zhang M. Effect of pillow height on the biomechanics of the head-neck complex: Investigation of the cranio-cervical pressure and cervical spine alignment. *PeerJ*,2016;4:e2397. [CrossRef] [PubMed]
11. Chen H-L, Cai D. Body dimension measurements for pillow design for Taiwanese. *Work*,2012;41:1288–1295. [CrossRef] [PubMed]
12. Li X, Hu H, Liao S. Can Pillow Height Effect the Body Pressure Distribution and Sleep Comfort: A Study of Quinquagenarian Women. In: *Proceedings of the 3rd International Conference on Energy Equipment Science and Engineering*, Beijing, China,2017:128:28–31.