

Body dimension measurements for pillow design for Taiwanese

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Abstract. Study reported a pillow with a uniform height was not suitable for sleeping in supine and lateral positions. The study aims to determine the pillow dimensions for fitting supine and lateral positions for Taiwanese. Ten females and ten males subjects with a mean age of 21.9 years (SD= 1.07 years) participated in the study. Body dimensions of head, neck and shoulder in crown and sagittal planes were measured with the Martins' anthropometer and a curve measurer to determine the pillow's sizes. The results showed that the basic form of pillow for both genders is a U form from the front view. The middle area of the pillow is for supine position and the both side areas are for lateral positions. The base of pillow is a rectangle from the top view. The pillow is designed with a width of 75 and 70 cm for male and female, and a depth of 40 and 35 cm for male and female. The height in middle area and both side are 4 and 14 cm for male, and 2 and 12 cm for female. A neck rest with a height of 1.5 cm was proposed for neck support.

Keywords: pillow design; sleep posture; anthropometry.

1. Introduction

Human beings spend one-third of life for sleeping. It occupies twenty-four years to an average life span of 72 years old. High quality and sufficient sleep is essential and required to the human. The function of sleep is similar to water, air and foods to human body. Sleep regulates daily living and the cognitive ability, judgment, and memory that are needed at work. . It maintains the human physiological functions and biological processes [1] . Kyle, Morgan, and Espie [2] pointed out that the quality of sleep is directly related to the human health as well as living standards.

Sleep posture also affects physical health. Leung Bowman, Parker, Newton, Douglas Bradley [3] concluded that to avoid abnormal cardiac functions due to external pressure, one should avoid the left lateral position. This is especially important for patients suffering from congestive heart failure. In addition, related research [4-7] reported that shoulder pain is a common musculoskeletal disorders. If unsuitable bedding is used, neck and shoulder muscles are likely to develop disorder symptoms . Research by Lavin, Pappagallo, and Kuhlemeier [8] suggested that using a suitable pillow can significantly reduce neck and shoulder pain.

Using a suitable pillow to have appropriate support on the head to maintain a natural curvature of the spine during the sleep can get a high quality sleep. There are many pillows in the market that were designed based on the shape of head and neck. They are supposed to increase the contact area between the neck and the pillow such that the pressure exerted upon muscles can be evenly distributed. This is workable for a fixed posture. However, people always changed their postures during sleep. Generally, two postures: supine and lateral positions were common used.

Study [9] have been concluded that a pillow designed with an uniform height is not being able to fit both supine position and lateral position during sleep. From the point of view on body dimension measurements, it is easy to understand that the distance from one's ear to shoulder in the crown plane is longer than the distance from one's hindbrain to the upper back in the sagittal plane. More, the results of observation [9] pointed out, when using the pillow in current markets for sleeping in the supine position, the front neck and throat of participants were bent and pressed. However, sleeping in the lateral position, the upper arm and shoulder of participants were pressed and the neck in upper side were bent extension. This means that the current pillow in markets is too high for people sleeping in supine position and is too low in lateral position. In order to provide a reference for

the pillow design, this study aims to investigate the changes of postures during sleep.

2. Methods

2.1 Subjects

Twenty students (10 females and 10 males) served as subjects participating in the study aging from 20 to 28 years with a mean age of 22.8 years (SD= 1.3 years). The mean stature of male and female are 175.07 cm (SD= 6.38) and 158.55 cm (SD= 5.28), respectively. The mean weight of male and female are 68.96 kg (SD= 9.71) and 51.94 kg (SD= 7.09), respectively.

2.2 Measurements and apparatus

The measurements of body dimension of Taiwanese subjects were measured in the standard posture were measured to determining the pillow's dimensions. The definitions of measurements are illustrated in Figure 1, Figure 2 and Table 1. There are two main experimental instruments in the study. One of them was a set of Martin's anthropometric measuring instrument, including stature gauge, beam callipers, slide callipers, outside callipers, tape measure, and ruler. The other instrument was a body-curve measurer made by the study.

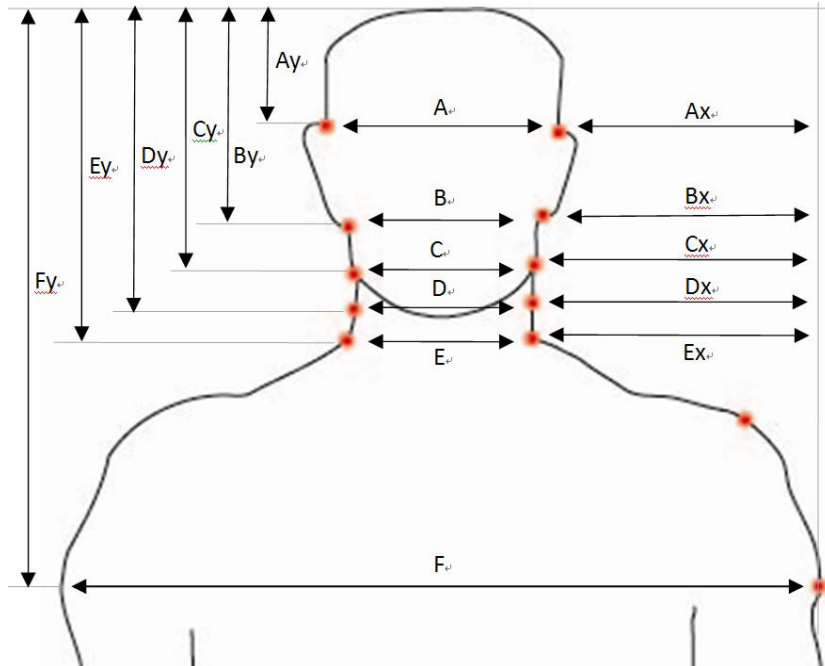


Figure 1. Illustration of body dimension measurements in crown plane

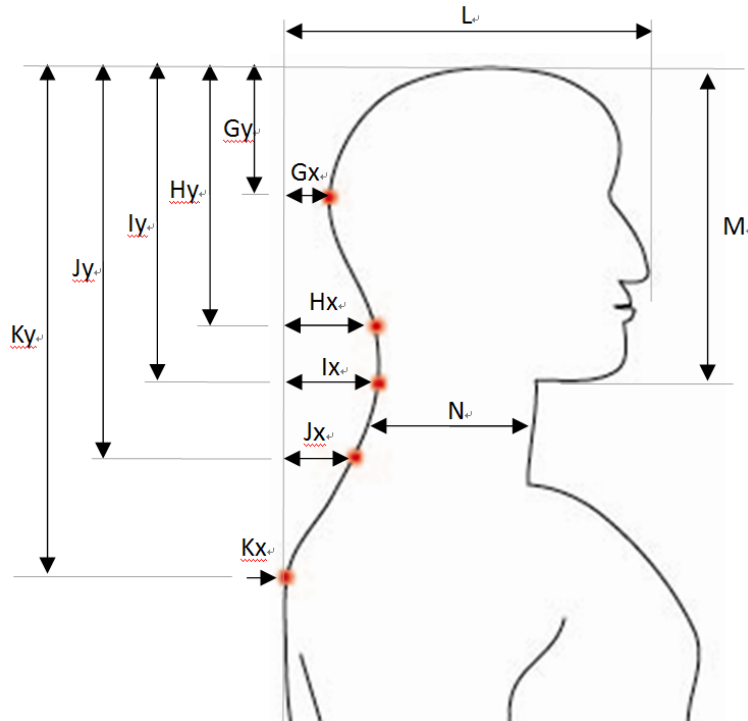


Figure 2. Illustration of body dimension measurements in sagittal plane

2.3 Experimented procedure

The experiment was conducted in an ergonomic laboratory at university. First, the researchers explained the experimental goals and guidelines to the subjects. Then, the subjects were measured for the several anthropometric dimensions (Table 1 and Table 2). Finally, measurements of the body dimensions were recorded.

3. Results and discussions

The statistics of body dimension measurements of the male subjects showed in Table 1. Table 1 listed the minimum, maximum, mean, and standard deviation. The stature and weight of the male are 175 cm and 69 kg. This is similar to the Taiwanese stature (171.70 cm) and weight (64.93 kg) measured by Wang, Wang and Lin (2002). The width from ear to shoulder is 14.26 cm $[(13.46+14.76)/2]$ and the width from neck to shoulder is 15.69 cm $[(15.79+ 15.94 + 15.36)/3]$. Whereas, the length from hindbrain to wall is 3.68 cm, and the length from neck to wall is 4.98 cm $[(5.53+ 5.69 + 3.71)/3]$. The difference between the width from ear to shoulder and the length from hindbrain to wall is 10.58 cm, and difference between the width from neck to shoulder is and the length from neck to wall is 10.71 cm. This illustrated a difference of 10.5 cm from head to bed surface in crown plane and in sagittal plane. That means the pillow height for supine position and for lateral position should be different with a difference of 10.5 cm. The difference between head and neck in crown plane and in sagittal

plane are 1.43 cm (15.69-14.26) and 1.3 cm (4.98-3.68), respectively.

Table 2 showed the statistics of body dimension measurements of the female subjects. The Table illustrated the minimum, maximum, mean, and standard deviation. The stature and weight of the female are 158.55 cm and 51.94 kg. This is similar to the Taiwanese stature (150.97 cm) and weight (51.97 kg) measured by Wang, Wang and Lin (2002). The width from ear to shoulder is 11.97 cm $[(11.39 + 12.55)/2]$ and the width from neck to shoulder is 13.98 cm $[(14.00 + 14.31 + 13.64)/3]$. Whereas, the length from hindbrain to wall is 1.44 cm, and the length from neck to wall is 2.79 cm $[(2.94 + 3.37 + 2.06)/3]$. The difference between the width from ear to shoulder and the length from hindbrain to wall is 10.53 cm, and difference between the width from neck to shoulder is and the length from neck to wall is 11.19 cm. That means the pillow height for supine position and for lateral position should be different with a difference about 10.5-11.2 cm. The difference between head and neck in crown plane and in sagittal plane are 2.01 cm (13.98-11.97) and 1.35 cm (2.79-1.44), respectively.

4. Pillow dimension design

According to the analytical results, we can get the guidelines for pillow design as following: (1) the pillow dimension for male and female should be different and need to build respectively. (2) the pillow height for supine position and for lateral position should be different with a difference of about 10.5 cm.

Table 1.

Body dimension measurement of male

Body dimensions	N	Min	Max	Mean	SD.
Age	10	24	21	22.10	1.10
Stature	10	165.0	186.5	175.07	6.38
Weight	10	48.0	83.0	68.96	9.71
A, Head breadth at upper edge of ear (otobasion)	10	15.2	16.6	15.80	.45
B, Head breadth at lower edge of ear (bitragion)	10	13.0	14.5	13.79	.49
C, Neck breadth at upper edge of neck	10	11.0	12.3	11.74	.41
D, Neck breadth at middle neck	10	10.8	12.2	11.43	.43
E, Neck breadth at lower edge of neck	10	11.7	14.3	12.60	.83
F, Shoulder breadth maximum	10	40.0	47.0	43.31	2.38
Ax, Width from upper edge of ear to shoulder	10	12.3	15.5	13.76	1.07
Bx, Width from lower edge of ear to shoulder	10	13.1	16.4	14.76	1.14
Cx, Width from upper edge of neck to shoulder	10	14.3	17.6	15.79	1.11
Dx, Width from middle neck to shoulder	10	14.5	17.6	15.94	1.06
Ex, Width from lower edge of neck to shoulder	10	14.0	17.1	15.36	1.07
Ay, Height from upper edge of ear to vertex	10	11.1	15.1	13.46	1.34
By, Height from lower edge of ear to vertex	10	17.1	20.7	19.03	1.20
Cy, Height from upper edge of neck to vertex	10	19.0	25.5	21.27	1.88
Dy, Height from middle neck to vertex	10	22.5	28.7	24.77	1.95
Ey, Height from lower edge of neck to vertex	10	26.3	31.0	29.15	1.49
Fy, Height from shoulder to vertex	10	33.4	41.4	35.98	2.23
Gx, Length from hindbrain to wall	10	.3	6.4	3.68	2.20
Hx, Length from upper edge of neck to wall	10	2.0	7.5	5.53	1.74
Ix, Length from middle neck to wall	10	2.7	7.0	5.69	1.36
Jx, Length from lower edge of neck to wall	10	1.4	6.5	3.71	1.61
Gy, Height from hindbrain to vertex	10	10.0	14.8	12.32	1.59
Hy, Height from upper edge of neck to vertex	10	16.6	21.0	18.17	1.48
Iy, Height from middle neck to vertex	10	21.4	25.3	22.87	1.25
Jy, Height from lower edge of neck to vertex	10	25.2	31.2	28.05	1.88
Ky, Height from upper back to vertex	10	35.0	43.3	39.90	2.88
L, Head length (pronasale to hindbrain)	10	16.8	21.7	19.79	1.38
M, Head height (menton to vertex)	10	19.9	27.1	23.10	2.21
N, Neck length	10	10.4	12.6	11.63	.68

Table 2.
Body dimension measurement of female

Body dimensions	N	Min	Max	Mean	SD.
Age	10	21	24	21.7	1.06
Stature	10	152.8	169.4	158.55	5.28
Weight	10	41.7	70.0	51.94	7.92
A, Head breadth at upper edge of ear (otobasion)	10	14.3	17.4	15.39	.82
B, Head breadth at lower edge of ear (bitragion)	10	11.5	14.1	13.06	.75
C, Neck breadth at upper edge of neck	10	9.2	11.9	10.16	.95
D, Neck breadth at middle neck	10	8.8	10.6	9.55	.62
E, Neck breadth at lower edge of neck	10	9.9	12.0	10.89	.75
F, Shoulder breadth maximum	10	36.9	40.7	38.16	1.45
Ax, Width from upper edge of ear to shoulder	10	10.8	12.6	11.39	.65
Bx, Width from lower edge of ear to shoulder	10	11.9	13.7	12.55	.63
Cx, Width from upper edge of neck to shoulder	10	13.1	15.7	14.00	.72
Dx, Width from middle neck to shoulder	10	13.6	15.9	14.31	.71
Ex, Width from lower edge of neck to shoulder	10	13.0	15.2	13.64	.72
Ay, Height from upper edge of ear to vertex	10	11.4	13.3	12.15	.66
By, Height from lower edge of ear to vertex	10	16.5	19.3	17.58	.89
Cy, Height from upper edge of neck to vertex	10	18.6	21.6	19.79	1.07
Dy, Height from middle neck to vertex	10	21.5	25.0	22.82	1.14
Ey, Height from lower edge of neck to vertex	10	24.8	28.2	26.77	1.16
Fy, Height from shoulder to vertex	10	29.5	33.6	31.47	1.43
Gx, Length from hindbrain to wall	10	.3	4.3	1.44	1.50
Hx, Length from upper edge of neck to wall	10	.5	5.8	2.94	1.79
Ix, Length from middle neck to wall	10	.9	5.8	3.37	1.54
Jx, Length from lower edge of neck to wall	10	.4	4.0	2.06	1.20
Gy, Height from hindbrain to vertex	10	9.2	15.2	11.06	1.76
Hy, Height from upper edge of neck to vertex	10	16.1	19.4	17.74	1.09
Iy, Height from middle neck to vertex	10	20.1	26.2	22.08	1.82
Jy, Height from lower edge of neck to vertex	10	25.2	32.4	27.09	2.11
Ky, Height from upper back to vertex	10	37.1	40.4	38.51	1.08
L, Head length (pronasale to hindbrain)	10	18.5	20.8	19.36	.66
M, Head height (menton to vertex)	10	18.5	23.4	20.94	1.52
N, Neck length	10	8.8	10.0	9.26	.44

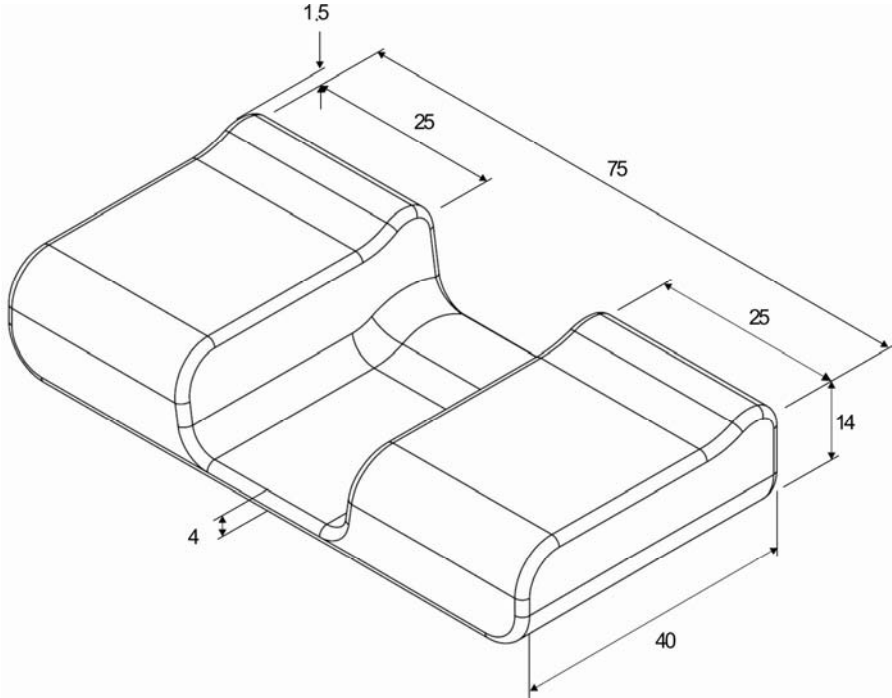


Figure 3. The pillow dimensions for young male

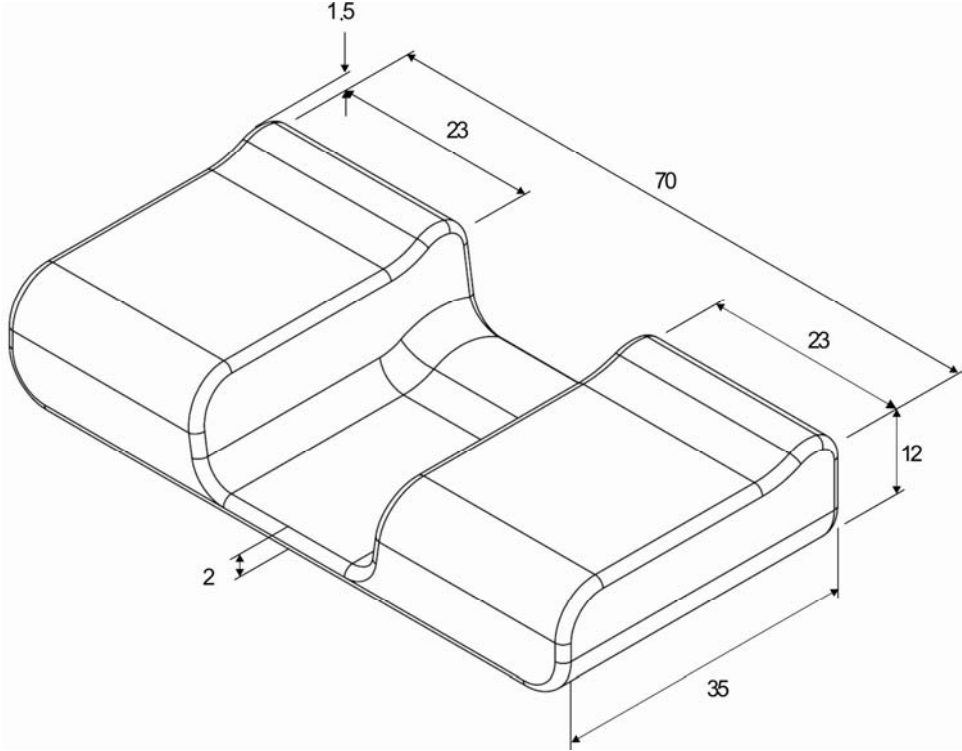


Figure 4. The pillow dimensions for young female

(3) the pillow width should be equal to shoulder breadth + head length + allowance. (4) the pillow depth should be equal to the height from shoulder to vertex + allowance. (5) A neck rest with about 1.5 cm should be proposed for pillow design for neck support during sleep. The dimensions of the pillow for male and female were showed in the Figure 3 and Figure 4, respectively.

5. Conclusions and suggestions

The study aims to determine the dimension for pillow design for Taiwanese. From the measurements of the body dimension and anthropometric data analysis, and the pillow design, we can get two pillow models for male and female. The basic form of the pillow for both genders is a U form from the front view. The pillow height of middle area is lower and that of both sides are higher. The middle area of the pillow is for supine position and the both side areas are for lateral position. Each area shared one third of pillow width. A neck rest with 1.5 cm of height is proposed to pillow design for neck support during sleep. The results showed that the dimensions of pillow for female and male are different. For male, the form of the base of pillow is a rectangle with a width of 75 cm and a depth of 40 cm from the top view. The height of middle area and both side are 4 cm and 14 cm, respectively. For female, the form of the base of pillow is a rectangle with a width of 70 cm and a depth of 35 cm from the top view. The height of middle area and both side are 2 cm and 12 cm, respectively.

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