Comfort of Cervical Pillow with Polyurethane Coil Springs

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ABSTRACT

Pillow as a part of the bed system plays a significant role in healthy sleep. The ergonomic and anatomic shape and construction of a pillow, as well as appropriate use of materials, create the main precondition for proper positioning of the head and neck. The requirements upon this product are defined by different sleeping habits, health condition, diseased conditions and other individual characteristics of a sleeper, and they define the shape, construction and anatomic characteristics of the pillows. How much change in the pillow affects the comfort of the user, this (pre)research has shown. It was conducted on an innovative pillow that contains PUR springs whose role is to create a space through which the air can flow more easily and thus remove the accumulated moisture from the pillows.

Key words: Comfort, Neck, Pillow, Polyurethane springs, Sweating

1. INTRODUCTION

Pillow as a part of the bed system plays significant role in healthy sleep (Grbac et al., 2006). Sleep, one of the important activities human beings pursue (Borazio and Van Laerhoven, 2012, quoted in Lin and Wu, 2015), occupies one third of time in human beings’ life. Thus the sleep quality indirectly affect our health. The definition of sleep quality on some occasions, “sleep quality” is used to refer to a series of sleep measures, including total sleep time (TST), total wake time, sleep onset latency (SOL), degree of fragmentation, sleep efficiency, and sometimes sleep disruptive events such as spontaneous arousals or apnea (Krystal and Edinger, 2008, quoted in Lin and Wu, 2015).

Pillow is one of the factors which affect our sleep quality, including snoring and waking symptoms. The main function of a pillow is to support the cervical spine in a neutral position to prevent more "end-range" cervical spine posture, which are considered to increase biomechanical stresses on cervical spine structures (Helewa et al., 2007; McDonnell, 1946; Jackson, 1976, quoted in Lin and Wu, 2015).

Cervical pillows come in a variety of heights and curves, with the goal of maintaining proper cervical spine alignment. Recent studies have shown that cervical pillow height is an important factor that affects the perception of pillow comfort (Erfanian et al., 2004; Liu et al., 2011, quoted in Wang et al., 2015). Erfanian et al. (quoted by Wang et al., 2015) showed that a cervical pillow with a uniform height is not appropriate for everyone. Therefore, the "best" cervical pillow height differs among individuals. Nevertheless, few studies have addressed methods for predicting a patient's preferred cervical pillow size. When trying to select a comfortable pillow among several sizes, most consumers base their choice on their physical "size". The authors found no statistically significant correlation between cervical dimensions and pillow height preference, and concluded that cervical measurements are not useful for predicting appropriate cervical pillow height. Therefore, the physical size of an individual may not serve as a good predictor for pillow height preference. Hence, recommendations of optimal pillow height based on physical size are inappropriate.

Neck and shoulder ailments are often encountered among the population; therefore, several researchers believe that an appropriate choice of pillows will be associated with these ailments (Jens, 2003; Bert et al., 2002; Guy, 2002, quoted in Liu et al., 2011). Kawabata and Tokura (1996) studied the thermal characteristic of a pillow on alleviating symptoms. These results suggested that reducing the temperature of the pillow may improve the quality of sleep.
Research of Okamoto et al. (2003) also showed that cool pillow design can reduce sweating and whole-body temperature, and indirectly improve the quality of sleep. These findings suggest that thermal characteristic of pillows may be related to the type of materials used. Kushida et al. (1999, 2001) reported that in patients with mild sleep disordered breathing, a cervical pillow helps reduces snoring and improves the quality and efficiency of sleep and the subjective-specific depth of sleep. Thus, these studies showed that the support provided by a pillow is strongly related to its shape. In addition to temperature, support, material, and shape, time factor of exposure to a pillow is another critical factor that affects the acceptance of a pillow. The research of Shields et al. (2006) showed that some patients may initially find cervical pillows uncomfortable. However, patients accept them after an extended use; and they will eventually be acceptable at the end (quoted in Liu et al., 2011).

With regard to a product design point of view, every product should be designed according to a target: a specific group of consumers. Because each target group has unique requirements, it is not realistic to have a single product that can satisfy all groups of consumers. Hence, it is important to identify the pillow design factors that affect a subject's comfort; and it is significant to design a better and properly suitable product (Liu et al., 2011). The fit of pillow-to-human form has not been reported in the literature (Gordon et al., 2009), and was not investigated in present study either. Authors continues that anthropometric studies may thus provide useful information regarding if, and what, anatomical parameters will ensure a comfortable, symptom free union between person, mattress and pillow.

Of all bed system components, a pillow is one that causes most concern whether night sleep would be deep and restful or it will cause painful neck (Grbac et al., 2005). Circadian rhythms, that is one of several biological rhythms found in humans, are produced jointly by the action of various structures of the nervous system and are influenced by various environmental factors, and also by sleep quality (Gracovetsky, 1987; Danda et al., 2005, quoted in Desouzart et al., 2015). The common sense warn that the quality of our day depends on the quality of our previous night. Among the main factors contributing to a better sleep quality is the postural behaviour during the sleep period. However, little or nothing is known about the actual influence of these behaviours on people sleep quality. Human health may have several problems that occur when sleep disturbances are verified, causing loss in the sleep quality, autonomic dysfunction and decreased professional or academic performance (Danda et al., 2005; Gracovetsky, 1987; Desouzart et al., 2014, quoted in Desouzart et al., 2015). This disruption of the normal circadian rhythm can result in fatigue, poor sleep quality, and degraded performance, gastrointestinal upset, and negative mood.

The aim of this study was to investigate the relationship between the pillow design and subjective comfort level in subjects during the 10 nights experiment in real conditions of sleep.

2. MATERIALS AND METHODS

The study of the comfort of the pillow made of visco-foam and polyurethane (PUR) springs was carried out during 10-night use in real sleeping conditions in the participant's sleeping rooms (Seleš, 2015).

Subjects provided their personal information before the experiment. That previous questionnaire included information pertaining to height, sex, age, height, weight, sleep posture preferences (lying on back or on a side), and existing spine problems.

Ten male (codes 1M...10M) and 12 female (codes 1F...12F) subjects, aged 21 to 42 years, height of 153 to 188 cm, mass of 44 to 113 kg and BMI of 17 to 32 kg/m² (Table 1) participated in the study. Subjects reported that 16 of them had no spinal problems, four had pain in the lumbar region, one had in the thoracic and one had in the cervical spine.
The sample-pillow is the patented product of the Croatian manufacturer and has been on the market for several years (Figure 1). According to producer, pillow is designed to optimally support and adjust the cervical spine to help prevent various illnesses or reduce existing ones.

![Image of sample-pillow](image.png)

**Figure 1. Cross-section of sample-pillow**
*(Trade name: Pospanko, producer: Bernarda d.o.o., Croatia)*

The main feature of the pillow are built-in polyurethane coil springs that simulates the air pumps along the entire cushion: under head pressure, the "spiral" springs push out moist air and drag in fresh air, thereby achieving faster moisture reduction in the cushion.

The pillow is made of anatomically shaped visco-foam (50 kg/m$^3$; 0.8 to 1.9 kPa ISO 2439-B, 40%). Dimensions of the sample were (l×w×h: 50×40×10/13) cm. The cover is made of Tencell knitted polyester wadding (56 % lyocell, 44 % polyester).

Brand new pillows (14 pieces) were using in the study, and each participant slept on a sample-pillow for ten nights in a row. According to Gordon *et al.* (2009), seven days appears to be a suitable period for a pillow trial as all dropouts occurred before the fifth trial day.

After five and after 10 nights, the subjects filled out a survey about sleep quality and comfort of sleeping on the pillow. Certain questions in both surveys were identical in order to compare the responses, or to determine which comfort factor changed after the respondent got used to the sample-pillow and whether there was a difference in comfort after five to ten nights.

### 3. RESULTS AND DISCUSSION

Responding to the previous questionnaire, all subjects were cite that, regardless experiment, use pillow during sleep. Fourteen subjects reported that their neck was not sweating during the night before the experiment, at four of them sweating is occasionally, and two subjects experience sweating during the nights (Figure 2).

About the habit of the most common position of sleep, the respondents prefer to sleep on the side (15), five on prone position and two on the back.
At the beginning of the experiment (after five nights of sleep on a sample-pillow) most of participants needs just 20 minutes to fall asleep, six of them reported time up to 40 minutes, and only one need more than 40 minutes to fall asleep (Figure 3). After 10th night of experiment majority of subjects need the same time to fall asleep, but for subjects 5F and 12F that time increasing for 20 minutes. On the other hand, subject 1F experienced 20 minutes decreasing of time.

When asked about sleep quality, half of respondents answered that they did not wake up during the night (Figure 4), while the other half did so once or twice. One respondent replied that, in the first five nights of experiment, he woke up more than two times per night, while after ten nights he said he woke up less, i.e. up to two times during the night. It can be said that the respondent needed five nights to get used to new pillow.

Subject 5M responded that he waking up one to two times during the first five nights of experiment, while after ten nights of sleeping on the sample-pillow, he waking up more than two times per night. Hence, the subject probably does not prefer this form of cushion.

Subject 11F said that she woke up one to two times in the first five nights, and after ten nights, she did not wake up at nights. After ten nights sleeping on a sample-pillow, two subjects answered that their number of waking ups decreased in comparison to the first five nights, while only one subject replied that in the second five nights, he woke up more than before.

The other 11 subjects answered that number of waking ups has not changed.
There were several answers to the question about the cause of waking during the night. Thus, 11 subjects answered that they did not waking during the night, and the same number claim that the cause of waking are pain, noise, etc. Beside, five subjects said after the first five nights that the cause of the wake ups was a sample-pillow (Seleš, 2015).

Figure 4. Frequency of waking up during each night of experiment

After all ten nights, one subject less replied that the pain was not caused by the pillow. During the first five nights, five subjects experienced a pain caused by a pillow, while only single one experienced the pain at end of experiment (Figure 5). In addition, 14 subjects claim that sample-pillow is the most comfortable while sleeping on side, and seven respond it is on the back. No responses were that pillow is comfortable while lying prone.

Figure 5. Answers about pain caused by sample-pillow

According to the survey results, 12 subjects answered that the sample-pillow is of ideal hardness, while 11 persons think that the pillow is too hard. No one replied that sample-pillow was too soft (Seleš, 2015).

Subjects who reported having pain in some part of the spine (6 persons) later stated that this pain manifests mostly in the evening and in the morning (Figure 6). Responses have shown that such pain is not wake-up-reason during the night (in 82 % of cases) and in only five case feel that this pain is caused by a sample-pillow (23 %).
Sixteen subjects argue that they did not pull-out the pillow overnight, while six people claim to rid-out of it. After ten nights on the sample-pillow, 17 respondents answered that they did not pull-out the pillow during the night, while five of them were (Figure 7).

If we observe appearance of sweating after 10 nights and after five nights of experiment (Figure 8) one can notice that 20 subjects (91%) did not reported sweating at all. In comparison with data before trial (Figure 2) that is significant improvement.
According to results shown on Figure 8, one participant (5M) feel the same rate of sweating after 5th and 10th night but in comparison with data prior to experiment the rate is higher, and one participant (10M) feel sweating more than usual after 10 nights, but also he experienced higher rate of sweating overall.

4. CONCLUSION

This study is characterized like pre-research because it is necessary to carry out similar research based on a higher number of participants, longer time of use and with more detailed every day survey.

According to the results of pre-research it can be concluded that the pillow fulfils its function of comfort and is designed to causes almost no sweating during use. There is a possibility of pain in the spine during the first few nights, but after the body becomes accustomed to change, that pain disappears and the users in the morning are more rested.

In addition to temperature, support, material, and shape, the time factor of exposure to a pillow is another critical factor that affects the acceptance of a pillow (Liu et al., 2011). As quoted in Lavin et al. (1997), if neck pain is exacerbated during sleep by poor head and neck support, then it is not surprising that individuals frequently awaken experiencing increased morning headaches and neck pain. Consequently, adequate head and neck support during sleep might have a beneficial carryover effect on daytime pain relief.

According to survey results (Seleš, 2015), most participants answered that the visco-foam is considered ideal material for the pillow. Likewise, its shape ensures proper neck support.

The opinions about the hardness of the sample-pillow are divided. Half of the subjects believe that the pillow is too hard, and the other half believe that the pillow is ideal. Everyone agrees that the pillow is not (too) soft.

Furthermore, it was concluded that the sample-pillow is not suitable for prone sleeping, mainly because it is too high, and people who prefer prone position would not be able to use or should change their habits.

Although after ten night, only one subject less (5 vs. 6) responded by removing the pillow during the night, and even though it can be concluded that the pillow is acceptable to the subject's population (because they probable adopt to pillow during the trial), is likely to be uncomfortable or too thick pillow, neck pain, etc. It is therefore important to carry out a wider study on different thicknesses of the pillow so that these claims can be proven.

Erfanian et al. (1998) assessed whether external measurements of the subject's neck are predictive of the preferred thickness of cervical pillow, given a choice of four different contour thicknesses. (...) After being given about 10 minutes to try the pillow out, subjects were asked to choose the most comfortable of the four thicknesses. This study found no statistically or clinically significant correlation between neck dimensions and pillow size preference. The authors suggested that pending further investigation, it may be prudent to continue recommending double-contoured or other variably-sized pillows.

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REFERENCES


