Evaluating the effect of mattress topper thickness and firmness combination on pressure and temperature distribution

Yu-Chi Lee, Chin-Yun Lee and Mao-Jiun Wang
Department of Industrial Engineering and Engineering Management
National Tsing Hua University
Hsinchu, Taiwan

Introduction:

The selection of a bedding system has direct relationship with sleeping quality. Placing a mattress topper is a common way to enhance sleeping comfort. Thus, the characteristics of mattress topper would be main factors to influence sleeping comfort. Jacobson et al. (2000) reported that a proper mattress can increase sleeping quality and decrease low back and shoulder pain. DeVocht et al. (2006) investigated the differences of pressure distribution and degree of spinal distortion between four popular commercial mattresses. Bader and Engdal (2000) estimated the relationship between sleeping quality and mattress surface firmness. Lahm and Iaizzo (2002) compared the effect of different mattress firmness on EMG activities, heart rates, blood pressures, subjective comfort levels and spinal alignment. Their results indicated that mattress firmness induced significant changes in spinal alignment.

The thickness of commercial mattress toppers normally ranged from 3 cm to 10 cm. However, there is a lack of information about the effect of thickness and firmness combination of mattress topper on sleeping comfort. Hence, the objective of this study was to evaluate the effect of thickness and firmness combination of mattress topper on pressure and temperature distributions.

Method:

Twenty males were recruited in this study. The experiment involves a combination of 3 different firmness (Hard: 20-30 °F; Middle: 15-20°F; Soft: 10-15 °F) and 4 thickness (3, 5, 7, 10 cm) levels. For each subject, whole body pressure and temperature distribution were collected to evaluate the firmness and thickness effect of mattress topper combination. Body pressure and temperature in six body regions including upper back, lower back, hip, thigh, calves and heel were measured. The experiment was conducted in a climatic chamber (HT-9745A, Hung Ta Instrument Co., LTD., Taiwan). The experimental ambient environment was specified at temperature of 26±0.5 ℃ and relative humidity of 60±3 % R.H. Each participant was asked to change their clothes into the experimental pajamas. The 12 mattress topper conditions were randomly assigned. During the experiment, all participants were requested to sleep on a bed system (mattress with selected topper) for 30 min with supine sleeping position (Figure 1). Participant was asked to rest about 5 min after each experiment condition. The effect of mattress topper firmness and thickness were tested by two-way analysis of variance (ANOVA). The Duncan's multiple range test (MRT) was conducted for post hoc comparison on the significant factor.

Results:

Two-way ANOVA results indicated that effect of firmness and thickness significantly influenced body pressure distribution in the selected six body areas. The higher pressures were observed in hard mattress topper and thick mattress toppers in the selected 6 body areas. The results of Duncan's MRT indicated that 3 cm soft mattress topper had the lowest pressure than the others (about 0.68 PSI) and 10 cm hard mattress had the worst performance (about 0.94 PSI) in average pressure (see Figure 2). On the other hand, ANOVA results of

temperature distribution showed that significant effect on firmness was found. In lower back, thigh, calf and heel area, the lower temperature was found in firm mattress topper. In upper back and hip area, the lower temperature was observed in soft mattress topper. Besides, thickness effect of mattress topper significantly influenced the temperature in the selected six body area except for thigh and calf area. Overall, the 3 or 5 cm hard mattress topper had lower body temperature (see Figure 3).

Conclusion:

In conclusion, the thin mattress topper (3 cm) has better performances on pressure and temperature distribution. For firmness effect of mattress toppers, the soft mattress topper has low body pressure but high body temperature. Customers can choose the mattress topper according to their needs. These findings can provide useful information for mattress topper production and selection.

Keywords: mattress topper, thickness, firmness, pressure distribution, temperature distribution

References:

Bader G. G. and Engdal S., 2000. The influence of bed firmness on sleep quality. Applied Ergonomics, 31, 487-497.

DeVocht J. W., Wilder D. G., Bandstra E. R. and Spratt K. F., 2006. Biomechanical evaluation of four different mattresses. Applied Ergonomics, 37, 297-304.

Jacobson B. H., Gemmel H. A., Hayes B. M. and Altena T. S., 2000. Effectiveness of a selected bedding system on quality of sleep, low back pain, shoulder pain, and spine stiffness. Journal of Manipulative and Physiological Therapeutics, 25, 88-92.

Lahm R. and Iaizzo P. R., 2002. Physiologic responses during rest on a sleep system at varied degrees of firmness in a normal population. Ergonomics, 45, 798-815.

Figures:

Figure 1. Experimental setting of this study

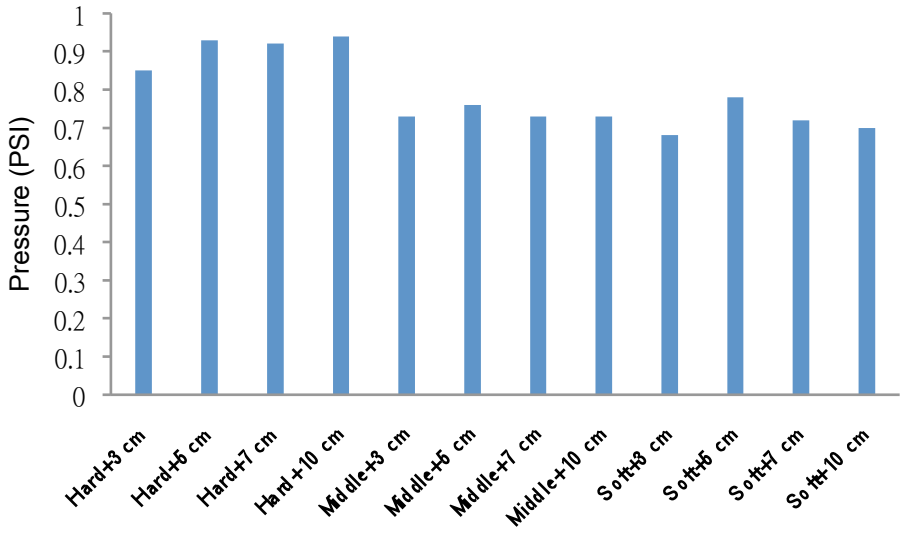

Figure 2. The average pressure measures of the 12 mattress toppers.

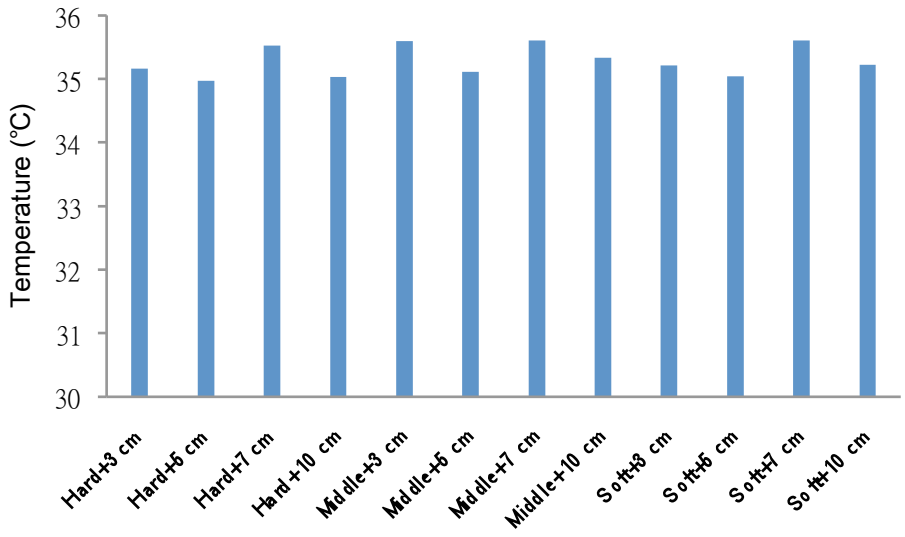

Figure 3. The average temperature measures of the 12 mattress toppers.