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# Effect of Quilt Materials on Sleep Quality and Thermal Comfort for Young People in East China

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## Abstract

This study investigated sleep quality and thermal comfort under different quilt materials (white duck down, white goose down and cotton) in non-heating bedroom for young people in East China via subjective and physiological methods. Thermal comfort and sleep quality were evaluated before and after sleep. Electroencephalograms were also obtained to determine the sleep stage. Both results show that quilt materials have a significant effect on sleep quality. The subjective results show that goose down quilt is evaluated the most comfortable in overall sleep comfort and sleep thermal sensation. The objective results show that the slow-wave sleep is the longest under goose down condition. Subjective and objective results are consistent, indicating that sleep quality is the highest when candidates were subjected to goose down material. Meanwhile, the study finds that lighter quilts would have a higher degree of satisfactions, indicating that young people in East China may have a preference for light quilt.

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*Keywords:* Sleep quality; Quilt; Thermal comfort; Physiological parameters; Duvet

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## 1. Introduction

About one-third of a person's life is spent in sleep and lack of sleep time or sleep quality can affect human health. Poor sleep quality impairs cognitive performance in the old people and impacts brain's reward processing, risk-taking, and cognition function in adolescents [1]. Sleep quality is affected by many factors, such as health conditions, emotional states, bedding condition and ambient environments.

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There have been limited researches about effects of bedding conditions on sleep quality and thermal comfort. The bedding system consists of many parts, such as quilt, mattress and sleep wear, which plays an important role in forming the bed micro-environment [2]. Survey results indicate that most rural residents in North China prefer to improve their bed climate instead of increasing the whole room temperature [3]. The reason for this phenomenon may be to achieve the purpose of energy saving, but also to prevent the physiological response and health discomfort caused by the big indoor and outdoor temperature step [4-6]. Overall, quilt as an integral part of bed micro-environment, its material and insulation level can affect the thermal comfort of sleep environment. Meanwhile, because of the discrepancies of age, gender, geographical distribution and other factors, people have different preferences on quilt materials. In order to estimate the effect of quilt materials on sleep quality and sleep thermal comfort of young people in East China, three types of quilts (white goose down, white duck down, cotton) were evaluated in the sleeping experiment via subjective and physiological methods. Proper materials of quilt can be applied according to typical climatic condition of one region and according to people 's habitual preferences to improve sleep quality and thermal comfort based on this kind of experiment.

## 2. Methods

### 2.1. Subjects

Eight volunteers (four male and four female) without sleep disorders gave their informed consent to participate in the experiment. Each subject had completed the Pittsburgh Sleep Quality Index(PSQI) [7] questionnaire, which evaluates sleep quality and disturbances over a one-month period. If the subject with a PSQI global score >5, which is considered to be suggestive of a significant sleep disturbance, he/she was excluded. All the subjects were required to live in East China including Shanghai, Jiangsu, Zhejiang and An-hui province for more than 2 years and were well adapted to the climate of East China. Also, all the candidates were non-smoker and had no medical history like high blood pressure, diabetes, asthma or chronic infections. The information of the eight subjects are shown in Table 1.

Prior to the experiment, the subjects were required to avoid alcohol, caffeine and intense physical activity on the day of the experiment. Meanwhile, we investigated their emotion with the profile of mood states short form (POMS-SF) [8] prior to experiment, which to confirm no significant mood difference between their 3-night sleeping.

Table 1 The data of the subjects.

Gender	Number	Age (years)	Height (cm)	Weight (kg)	BMI (kg/cm <sup>2</sup> )	PSQI
Male	4	24±3	178.5±1.7	72.0±6.8	22.6±2.3	3±1
Female	4	23±1	162.9±3.1	55.5±5.9	20.9±2.2	3±2
All	8	23±3	170.7±8.7	63.8±10.6	21.8±2.1	3±2

### 2.2. Experiment design

The experiment was conducted in two sleep chambers in Shanghai, January, 2016. The indoor temperature and humidity simulated the general thermal environment of non-heating bedrooms in winter in Shanghai. SHI et al.'s research on the questionnaires and field measurements in Shanghai showed that the temperature of bedroom in winter was about 11 °C [9]. The study of Lyu et al. also found that 12°C 50%-60%RH was the average bedroom temperature and humidity for young people in Shanghai [10]. Therefore, 11°C 45-65%RH was selected as the ambient temperature and humidity in this study.

A repeated measures design (the same subjects were repeat-measured in 3 different conditions) which allowed fewer subjects and more efficient offset of individual differences was applied in the experiment. Moreover, the number of subjects in existing similar studies on sleep ranged from four to eight [11,12]. Thus, 8 subjects (4 males

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