Difference of cooling use during sleep between elderly and young people

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Abstract. In Japan, nearly 80% of heatstroke occurrences in recent years have involved people older than 65 years old. This study surveyed the actual use of cooling by elderly people at sleep time compared to those found for younger people. Results revealed the followings. 1) Ratios of cooling use at sleep time were 30.8% for elderly people and 57.4% for younger people. The respective ratios of natural ventilation use at sleep time were 39.9% and 32.4%. 2) Average wet bulb globe temperatures (WBGTs) of bed rooms during sleep were 26.9°C for elderly people and 26.4°C for younger people. 3) Elderly people feel warmer than younger people but they feel more thermally comfortable. 4) Sleep scores were 49.7 for elderly people and 48.5 for younger people. No difference was found for the frequency of night waking or the Sleep maintenance score, but the Fatigue recovery score showed the greatest difference between elderly and younger people.

1. Introduction

Sultry nights on which the minimum temperature remains higher than 25°C have become increasingly common in the urban area of Osaka, Japan. The average numbers of sultry nights rose to become 43.6 during 2010–2017. More than 56,000 patients were emergency-transported; 1,731 were killed by heat stroke during the heat wave in 2010 in Japan. Heat stroke risk has become a matter of greater concern. Moreover, more than 80% of the deaths were of elderly people over 65 years old. Half of the heat stroke deaths occurred in houses.

This study surveyed the actual use of cooling by elderly people at sleep time. After investigating cooling effects on sleep quality and thermal sensation, we compared the results to those found for younger people. Typical households in Japan possess 2–3 air conditioners. However, some investigations have shown that air conditioners were not always used and natural ventilation were preferred. Thermal environment, thermal comfort and sleep quality were surveyed along with use of air conditioners, electric fan and natural ventilation.

2. Methods

During five years, we surveyed Osaka apartment residents: 65 elderly people (over 65 yr) on 392 nights and 113 younger people (<65 yr) on 561 nights. The respective average ages of elderly and younger people were 73.2 yr (SD 6.6 yr) and 45.7 years old (SD 11.0 yr).

Bed side air temperature was measured for a week at intervals of 10 min. Relative humidity was recorded before and after sleep. Air-Conditioners use, electric fans use, natural ventilation use, bedroom occupation and sleep were recorded at intervals of 30 min. Thermal sensation, sleep clothing and subjective sleep quality measured by OSA sleep inventory [1] [2] were answered after sleep every
morning. Average thermal environment during sleep were contrasted with the evaluated results in this study. Figure 1 shows the changes of number of measured nights and daily mean outdoor temperature. Number of nights is the total of five years survey and outdoor temperature is the mean of five years. More than nine measurements were done for a night till the beginning of September. Figure also shows that daily mean temperature was higher than 28°C in summer and often exceeded 30°C till the middle of August in Osaka.

3. Results and Discussion
Figure 2 shows frequency distributions of Wet Bulb Globe Temperature [3] of elderly and younger people during sleep. WBGT in bedrooms were estimated from air temperature and relative humidity [4]. Ratio of ‘Caution (WBGT between 25°C and 28°C)’ and ‘Much caution (WBGT between 28°C and 31°C)’ were 50.9% and 37.5% for elderly people and 54.8% and 26.9% for younger people. Average WBGT were 26.9°C and 26.4°C for elderly and younger people respectively ($p=0.0009$).

Figure 3 compares time ratio of AC, electric fan and natural ventilation use during sleep between elderly and younger people. Mean time ratio of AC use during sleep was 0.31 for elderly people where 0.57 for younger people. Mean ratio of natural ventilation use for elderly people was 0.40 for elderly people where 0.32 for younger people. Difference by age was larger for AC use than natural ventilation use. Relative frequency of all-night AC use was 12.5% for elderly people where 32.8% for younger people. Relative frequency of all-night natural ventilation use was 26.0% for elderly people, where 11.3% for younger people. Elderly people prefer open windows to using air-conditioners during sleep.

Figure 4 presents clothing patterns during sleep. 47.0% of elderly people wore long trousers while 28.4% of younger people did. Average clothing insulation were 0.35 clo and 0.30 clo for elderly and younger people respectively ($p<0.0001$). Elderly people tend to wear warmer clothing and sleep in warmer environment. Average SET was 25.7°C and 25.3°C for elderly and younger people respectively ($p=0.0047$).

Figure 5 compares thermal sensation and thermal comfort evaluation distributions. Thermal environment was evaluated in warmer and cooler side 40.0% and 21.5% for elderly people, where 35.4%...
and 29.7% for younger people \((p=0.010)\). However, elderly people felt more comfortable than younger people \((p=0.020)\).

Figure 6 shows OSA sleep quality scores. Score of Factor 1 ‘Drowsiness when waking’ and Factor 4 ‘Fatigue recovery’ were higher for elderly people \((p=0.0002, p<0.0001\) respectively). Mean awaking frequency during sleep was 1.75 for elderly and 1.61 for younger people, but no difference was found between two groups in score of Factor 2 ‘Maintaining sleep’.

If difference between electric charge in August and May is defined as cooling use, no difference was found between elderly \((3749.2\) yen) and younger people \((3833.5\) yen) \((p=0.88)\). Further investigation is needed about energy use effects of thermal control use during sleep.

4. Conclusions
Elderly people over 65 years old tend to sleep in warmer environment with more heavy sleep clothing than younger people. They use air conditioners during sleep not so much frequently as younger people but no difference is found in cooling charge. They feel warmer than younger people but feel thermally more comfort. Subjective sleep quality scores are better in ‘Drowsiness when waking’ and ‘Fatigue Recovery’ factors than younger people, although there is no difference in ‘Maintaining sleep’ score.

It looks like there are little problem in thermal comfort, sleep quality and energy use of elderly people in summer sleep, but it is serious that ratio of ‘Caution’ and ‘Much caution’ in heat stroke prevention guideline for elderly people were 50.9 \% and 37.5 \%.

References
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