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Effect of a warm footbath before bedtime on body temperature and sleep in older adults with good and poor sleep: An experimental crossover trial

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Abstract

Background

The decrease in core body temperature before sleep onset and during sleep is associated with dilation of peripheral blood vessels, which permits heat dissipation from the body core to the periphery. A lower core temperature coupled with a higher distal (hands and feet) temperature *before sleep* are associated with shorter sleep latency and better sleep quality. A warm foot bath is thought to facilitate heat dissipation to improve sleep outcomes.

Objectives

This study examined the effect of a warm footbath (40 °C water temperature, 20-min duration) on body temperature and sleep in older adults (≥55 years) with good and poor sleep.

Design

Two groups and an experimental crossover design was used.

Setting and participants

Forty-three adults responded to our flyer and 25 participants aged 59.8±3.7 years (poor sleeper with a Pittsburgh Sleep Quality Index score≥5=17; good sleepers with a Pittsburgh Sleep Quality Index score<5=8) completed this study.

Methods

All participants had body temperatures (core, abdomen, and foot) and polysomnography recorded for 3 consecutive nights. The first night was for adaptation and sleep apnea screening. Participants were then randomly assigned to either the structured foot bathing first (second night) and non-bathing second (third night) condition or the non-bathing first (second night) and foot bathing second (third night) condition.

Results

A footbath before sleep significantly increased and retained foot temperatures in both good and poor sleepers. The pattern of core temperatures during foot bathing was gradually elevated (poor sleepers vs. good sleepers=+0.40±0.58°C vs. +0.66±0.17°C). There were no significant changes in polysomnographic sleep and perceived sleep quality between non-bathing and bathing nights for both groups.

Conclusion

A footbath of 40°C water temperature and 20-min duration before sleep onset increases foot temperatures and distal–proximal skin temperature gradients to facilitate vessel dilatation and elevates core temperature to provide heat load to the body. This footbath does not alter sleep in older adults with good and poor sleep.

Introduction

The human sleep–wake rhythm is synchronized with the circadian body temperature rhythm. Circadian body temperature rhythms are suggested to be a signaling pathway for the modulation of sleep and wakefulness (Van Someren, 2000c). During the daytime, humans are actively awake and experience an increased core body temperature. After core body temperature peaks around 16:00–20:00, core temperature declines and prepares the body to retire (Lack and Lushington, 1996, Van Someren, 2000a, Van Someren, 2000b). The decrease in core temperature rhythms in the evening is mainly determined by heat loss from the core to the distal body (extremities), which is associated with increased skin temperature in the extremities (Krauchi, 2002, Krauchi et

al., 1999, Krauchi et al., 2000, Van Someren, 2000c). Warming the skin can activate the preoptic anterior hypothalamus (Egan et al., 2005), a key structure in sleep regulation (Culebras, 2002). Amplitude, the difference between the peak and trough of core body temperature is associated with sleep depth (Carrier et al., 1996). The gradient of temperature from proximal body sites (infraclavicular, thigh, stomach, forehead) to peripheral sites (feet and hands) (distal–proximal skin temperature gradient, DPG) is an indirect measure of heat dissipation or loss from the core to the periphery and is a predictor of sleepiness (Krauchi et al., 1999, Krauchi et al., 2000).

Over one-fourth of older adults experience chronic sleep difficulties (Doi et al., 2001), including prolonged sleep latency (i.e. >30 min), prolonged awakenings (i.e. >30 min), and reduced sleep efficiency (i.e. <85%), which are often considered indicative of insomnia (Vitiello et al., 2004). These difficulties may be associated with sleep architecture changes in polysomnography (PSG) in which wakefulness and light sleep (stages N1 sleep) are increased, and deep sleep (stages N3 sleep) is reduced or absent in the elderly (Floyd et al., 2000b, Van Someren, 2000b). Compared to young adults, older adults have a blunted reduction (trough point is higher than expected) in core body temperature during sleep (Carrier et al., 1996), which may be associated with reduced or absent deep sleep. Body heat may be retained due to reduced heat dissipation from the core to the periphery. Manipulating body temperature can be a potential intervention to facilitate sleep in older adults because long-term pharmacological treatment for insomnia is limited.

Previous studies have shown that passive body heating, such as foot bathing, can manipulate body temperature and affect sleep. A warm footbath (42 °C) for 30 min is adequate to improve sleep onset latency and sleep quality without raising core body temperature in young adults (Raymann et al., 2005, Sung and Tochihara, 2000). However, a footbath of 41 °C for 40 min before bedtime did not have significant effects upon sleep outcomes overall in older adults with sleep disturbances (Liao et al., 2008). This 41 °C 40-min footbath in older adults decreased awakening until the second non-rapid eye movement (NREM) sleep period. It may be due to elevated core temperature before bedtime after the 41 °C 40-min foot bathing (Liao et al., 2008). Increased core temperature and delayed sleepiness may imply that heat is transferred to the whole body during foot bathing. A warm footbath not only increases peripheral skin blood flow but also increases core body temperature. Because elevated body temperature during sleep is associated with more physiological arousal in insomnia (Krauchi et al., 2000), lower water temperature for a shorter duration has been suggested for further examination. Moreover, it is unclear whether differences exist in thermoregulation between older adults with good and poor sleep. Therefore, in this study, we repeated our previous footbath study by using lower water temperature (40 °C) with shorter bathing

duration (20min) and comparing its effect on body temperature and sleep outcomes between older adults with good and poor sleep.

Section snippets

Study design

Two groups with an experimental crossover design were employed to examine the effect of foot bathing on body temperature and sleep quality in older adults with good and poor sleep. All participants slept three consecutive nights in the sleep laboratory of a medical center. The first night was for adaptation and sleep apnea screening. Participants were then randomly assigned to either the structured foot bathing first (second night) and non-bathing second (third night) condition or the …

Participant characteristics

Thirteen females and twelve males with mean ages of 59.8 (SD=3.7) years participated in this study. Most participants were married, retired, and had 6–14 years of education. Participants in the PS group had a global PSQI score ≧5, indicative of poor sleep. Subjective sleep in the past month including total sleep time and sleep efficiency measured by the PSQI differed between the PS and GS groups (Table 1). …

Effects of foot bathing on core body temperatures and DPG during foot bathing and sleeping

In the GS group, mean core body temperature gradually decreased on non-footbath nights (…

Discussion

Multiple factors may affect the relationship between body temperatures, thermoregulation and sleep in older adults. In this study, we examined the effects of a footbath received shortly prior to sleep on body temperature and sleep quality in older adults with good and poor sleep. Our results show that a warm footbath of 40°C for

20 min raised foot temperature and core body temperature but had no significant effects on PSG and perceived sleep in older adults with good or poor sleep. These results …

Conclusion

Passive heating prior to sleep onset significantly elevated foot temperature and DPG but did not change objective and subjective sleep quality. Distal warming may not be as effective as proximal warming. In addition to body temperature, sleep is affected by multiple factors, such as mood, life events, and sleep state misperceptions. Single interventions, such as foot bathing, may have only a weak effect and may not be appropriate for everyone. A comprehensive sleep assessment and cluster …

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Conflicts of interest: None.

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Ethical approval: The Institutional Review Board of the Chung Shan Medical University Hospital approved this study no. CS05053.

Contributors: Drs. Liao and Tin had full access to all …

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