行政院國家科學委員會專題研究計畫　成果報告

泡腳對居家老年人體溫與睡眠之成效探討

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中文摘要

（一）計畫中文摘要。(五百字以內)

睡眠是一項重要且能恢復人體能量的活動，然而約有14.0%~42.2%的社區老人承受睡眠困難之苦。研究顯示入睡和睡眠的維持與核心體溫的降低及週邊腳溫的升高有關。因此執行被動地加熱身體(泡腳)，使週邊血管擴張腳溫升高，也許可以減輕老人失眠，促進其睡眠品質。

本研究為兩年之研究計畫，將使用隨機交叉設計，檢測40°C水溫20分鐘的泡腳措施，對有及無主訴睡眠障礙老人之體溫與睡眠的影響。第一年主要之工作為測試研究機器，建立睡眠研究室標準，開始收集研究樣本睡眠與體溫資料並給予泡腳處置。目前6位個案完成此研究，核心體溫、腹溫、足溫與DPG在有無泡腳之間的趨勢類似，PSG、actigraphy、與主觀睡眠品質在有無泡腳也無顯著差異。然而，睡眠潛伏期在泡腳的晚上有減少的趨勢，顯示個案在泡腳後可能可以好入睡一些。第二年將收集更多個案，並分析睡眠與體溫資料。研究結果可提供處置老人睡眠障礙的參考。

英文摘要

（二）計畫英文摘要。(五百字以內)

Sleep is a vital and restorative human function. However, 14.0% to 42.2% of the community dwelling old adults suffer from sleep difficulties. Studies have shown that decreased rectal temperature and increased foot temperature correlate with the occurrence of sleep onset and maintenance. Passive body heating (footbath) help to dilate peripheral vessels may be a non-pharmacological intervention to reduce insomnia and improve sleep quality in older adults.

This two-year study use a randomized crossover design to examine the effect of a warm footbath with 40°C water temperature and 20 minute duration on body temperatures and sleep in older adults with and without self-reported sleep disturbances. This is the first year report. All devices were tested and calibrated. Protocol of sleep research was developed. Six subjects completed this study. Trends of core, abdominal, and foot temperatures, and DPG (distal-proximal-skin temperature gradient) were similar between non-bathing and bathing nights. There were no significant sleep changes in PSG, actigraphy-estimated sleep, and perceived sleep quality between non-bathing and bathing nights. However, there was a trend that PSG sleep latency was decreased after foot bathing. This indicated that foot bathing before sleep onset has a potential to make falling asleep easier. More subjects are recruiting. Findings from this study will provide information for managing sleep in elders.

關鍵詞：older adult, sleep disturbance, body temperature, sleep, foot bathing

Introduction

Sleep difficulties are common in the elderly. They complained of trouble falling asleep, frequent or prolonged nocturnal or early morning awakening with an inability to return to sleep. These complaints are corresponded with insomnia symptoms of difficulty initiating and maintaining sleep. The overall prevalence of insomnia ranges from 14.0% to 42.2% in the general elderly population (Chiu et al., 1999; Foley et al., 1995; Ganguli, Reynolds, & Gilby, 1996; Kim, Uchiyama, Okawa, Liu, & Ogihara, 2000; Newman, Enright, Manolio, Haponik, & Wahl, 1997; M. Ohayon, 1996; M. M. Ohayon, 1997; M. M. Ohayon & Zulley, 2001; Rocha et al., 2002). Further examination of sleep structure demonstrates that the elderly have reduced amount or a total lack of stages 3 and 4 sleep (also called slow wave sleep, SWS), and more stage 1 and stage 2 sleep (Floyd, Medler, Ager, & Janisse, 2000; Van Someren, 2000a, 2000b; Wauquier, 1993). These sleep disorders in the elderly is often associated with increased risk of accidents, falls, chronic fatigue, impaired functioning and poor quality of life (Brassington, King, & Bliwise, 2000; Cricco, Simonsick, & Foley, 2001; Qureshi, Giles, Croft, & Bliwise, 1997). Hypnotics can reduce their sleep problems. However, adverse effects of hypnotics such as anterograde amnesia, and potentially compromised respiratory function should be taken into consideration and may limit the use of hypnotics in the elderly (Lenhart & Buysse, 2001). Discontinuing hypnotics also results in rebound insomnia and nightmares (Grad, 1995; Ramesh & Roberts, 2002), which even makes sleep worse.

Non-pharmacological treatments have fewer side effects and can be an alternative for the elderly. Recent studies have shown close relationship between body temperature oscillation and sleep wake cycles (Dijk & Czeisler, 1995; Khalsa, Jewett, Duffy, & Czeisler, 2000; Krauchi & Wirz-Justice, 2001). Usual sleep onset time coincides with the time of decreasing core body temperature. It has been found that decreased rectal (core) temperature and increased foot (peripheral) temperature correlate with the occurrence of NREM sleep (Burgess, Holmes, & Dawson, 2001; Krauchi, Cajochen, Werth, & Wirz-Justice, 1999, 2000). Decreased rectal temperature may be due to vasodilatation of peripheral vessels, resulting in increased foot temperature and heat loss from the core to the peripheral of the body. The gradient of temperature from proximal body sites (infraclavicular, thigh, stomach, forehead) to peripheral sites (feet and hands) is an indirect measure of heat dissipation or loss from the core to the peripheral. This gradient of distal-proximal skin temperature (DPG) is a predictor of sleepiness (Krauchi et al., 1999, 2000). Passive body heating, such as a warm bath prior to sleep, has been shown to improve sleep quality in the elderly (Dorsey et al., 1996; Dorsey et al., 1999; Kanda, Tochihara, & Ohnaka, 1999), hence may benefit the elderly who are suffering from sleep difficulty.

Specific aims

The specific aims of this study are to

1. Examine the effect of warm footbath on
   - a). The distal (foot)-proximal (abdominal) skin temperature gradient (DPG) and core temperature
   - b). Polysomnography sleep latency, number and time of nocturnal awakenings, slow wave sleep (stages 3 and 4), and sleep efficiency.

c). Actigraphy sleep latency, number and time of nocturnal awakenings, and sleep efficiency.

d). Perceived sleep quality (restoration, satisfaction, overall).

2. Compare the differences of effects of warm footbath between older adults with and without sleep disturbances.

Methods

Design and Procedure

Two groups, experimental crossover design was used to examine the effect of foot bathing on distal-proximal body temperature gradient and sleep quality. Older adults with and without sleep disturbances were recruited as experimental and control groups, respectively. All participants spent three consecutive nights in a sleep laboratory. The first night was for adaptation and sleep apnea screening, and then they were randomly assigned to either the structured foot bathing first (second night) and non-bathing second (third night) condition, or non-bathing first (second night) and foot bathing second (third night) condition. All participants received both a night with foot bathing in the late evening 30 min before bedtime and a night without bathing (control condition). Bedtime was decided by the individual's usual routine. Participants were asked to keep regular meal before bedtime. Researchers controlled room temperature, light and noise level during sleeping time.

Participants

Six healthy older adults completed this study. They were aged 55 years old and above with a mean age of 58.2 years (SD=2.6). Four were female. Five subjects complained poor sleep (PSQI>5). None of them had sleep apnea (AI<10/hr).

Foot bathing intervention

Water temperature and duration of the foot bathing was set at 40°±0.5C for 20 minutes. Their legs were immersed in warm water up to knee level. A special designed bathtub kept water temperature constantly at set degree. Foot bathing was administered 50 minutes before usual bedtime and finished 30 minutes before usual bedtime.

Measures

Polysomnography, actigraphy, and body temperatures were measured overnight. Perceived sleep quality was assessed by the Post-Sleep Questionnaire (PSQ) in the morning.

<u>Polysomnography (PSG)</u>

Polysomnography (PSG) is the gold standard for measuring sleep and is composed of the electroencephalogram (EEG), electro-oculogram (EOG), and electromyogram (EMG) (Rechtschaffen & Kales, 1968). Total sleep time, sleep efficiency, sleep latency, sleep stages, and awakening within sleep period are the sleep indicators estimated via PSG. Total sleep time is the total time in sleep including NREM and REM sleep. Sleep efficiency is the ratio of total sleep time to time in bed for sleep. Sleep latency is the time it takes for falling asleep, which is the period from wake trying sleep to stage 2 sleep. Intermittent awakenings are the numbers of times wake or Stage 0 occurs.

<u>Actigraphy</u>

Actigraphy that records body motion is used to detect activity level and estimate sleep or wake state. Actiwatch (Mini Mitter Co., Inc. Oregon), a watch-like device for measuring wrist activity, was used for this study. Non-dominate wrist movement was monitored. Participants wore Actiwatch 24 hours continuously at each study time points except taking showers and also keep sleep diary for reference of activity. Sleep indicators including total sleep time, sleep latency, wake after sleep onset, and sleep efficiency were calculated as well.

Body temperatures

Participants swallowed a core thermistor capsule (Mini Mitter Co., Inc. Bend, Oregon USA) to record core temperatures for 2 days. Abdominal and foot skin temperature represents proximal and distal skin temperature respectively by attached skin thermistor patches (Mini Mitter Co., Inc. Bend, Oregon USA). DPG (distal-proximal skin temperature gradient) was obtained by subtracting abdominal temperature from foot temperature. The VitalSense monitor (Mini Mitter Co., Inc. Bend, Oregon USA) were used to measure these three sites of body temperature.

Post-Sleep Questionnaire (PSQ)

The Post-Sleep Questionnaire (PSQ) was used to assess sleep quality. It consists three questions regarding self-perceived sleep latency, sleep duration, and awakening, two self-administered descriptors with 1 to 10 visual analog scale (VAS) regarding sleep quality, and satisfaction. The higher score is associated with better sleep. Participants filled out this questionnaire every morning after awake.

Results

Body temperatures

Figure 1 displays core, abdominal, and foot temperatures. The trends of the three temperatures were similar between non-bathing and bathing nights. Figure 2 displays DPG between non-bathing and bathing nights, which also demonstrated similar pattern between two nights.

Body temperatures between bathing and non-bathing nights

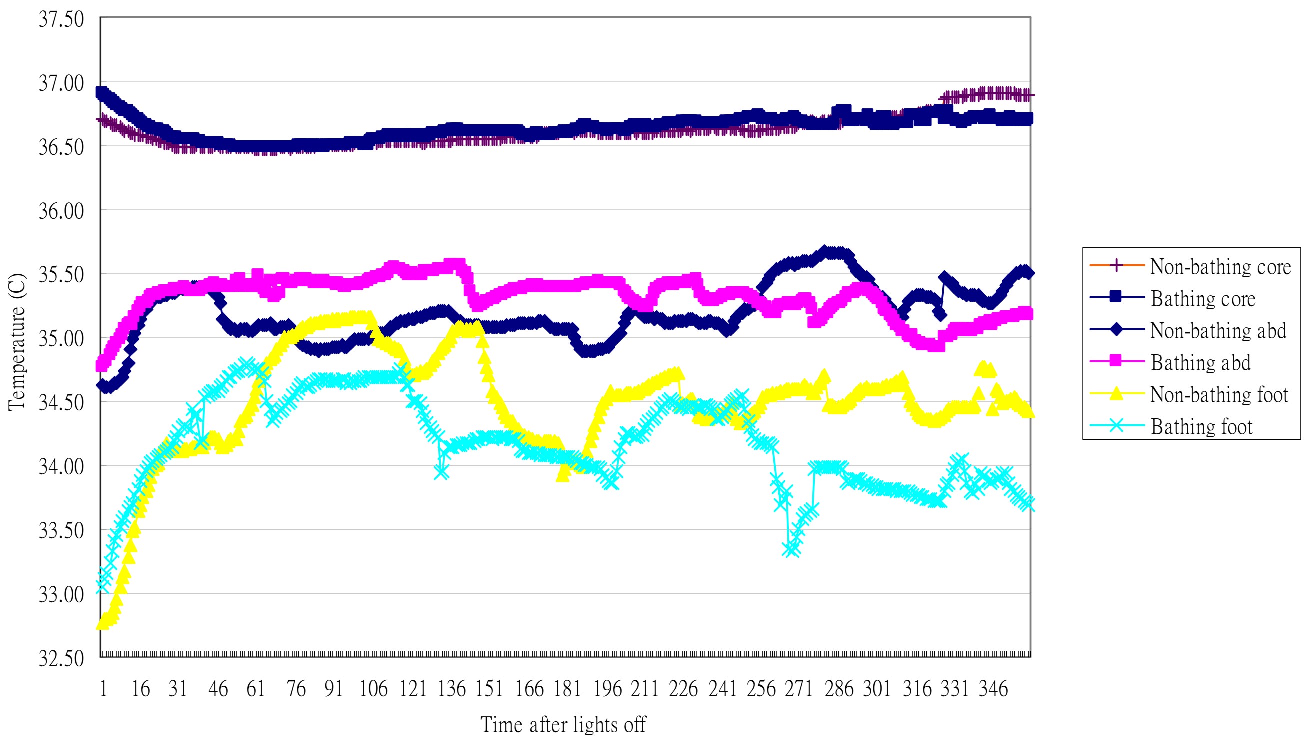
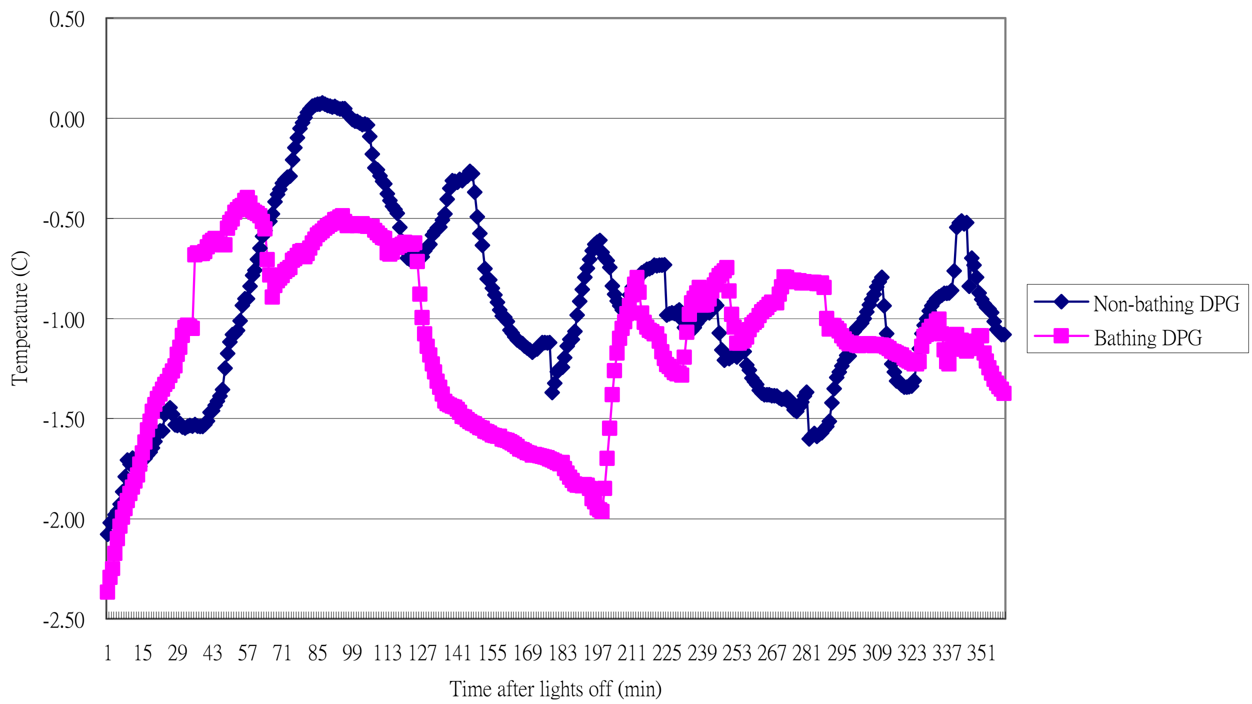


Figure 2. DPG between bathing and non-bathing nights



Sleep

Polysomnography (PSG), actigraphy-estimated sleep, and perceived sleep quality in Table 1 show the results of sleep between non-bathing and bathing nights. Due to small sample size, there were no significant findings between non-bathing and bathing nights. However, there was a trend that PSG sleep latency was decreased after foot bathing. This indicated that foot bathing before sleep onset has a potential to make falling asleep easier.

Table 1. Polysomnography, Actigraphy-estimated sleep, and perceived sleep between non-bathing and bathing nights

	Non-bathing		Bathing			
	Mean	S.D.	Mean	S.D.	t	Sig
Polysomnography						
Total sleep time (min)	327.8	57.4	332.9	43.6	-0.27	0.80
Sleep latency (min) (to stg 2)	3.8	7.6	17.8	13.8	-2.28	0.07
Wake after sleep onset (min)	59.3	43.2	33.3	19.2	1.68	0.15
Sleep efficiency (tst/tib) (%)	84.7	8.7	85.8	8.1	-0.53	0.62
Sleep stages (% sleep period time)						
Stage 1	4.3	2.0	4.1	1.7	0.25	0.81
Stage 2	47.6	14.9	55.1	7.1	-1.23	0.27
Stage 3	12.2	11.2	10.9	7.7	0.37	0.73
Stage 4	1.6	3.8	0.3	0.5	0.94	0.39
REM	18.6	7.7	19.7	7.1	-0.32	0.76
Actigraphy sleep						
Total sleep time (min)	337.8	33.9	357.7	37.2	-1.33	0.24
Sleep latency (min)	13.0	8.9	16.5	16.4	-0.49	0.64
Wake after sleep onset (min)	24.0	14.9	23.7	15.4	0.08	0.94
Sleep efficiency (%)	88.0	5.2	88.6	5.0	-0.47	0.66
Perceived sleep						
Total sleep time (min)	390	60	392.5	36.0	-0.07	0.94
Sleep latency (min)	38.3	19.4	40	29.7	-0.09	0.94
Wake after sleep onset (min)	19.2	11.1	17.2	13.6	-0.27	0.80
Sleep efficiency (%)	74.7	14.6	78.5	10.7	-0.52	0.63
Sleep quality	7.3	1.5	6.7	1.2	0.70	0.52
Sleep satisfaction (scale)	7.5	1.6	6.7	1.2	0.88	0.42
Satisfaction (catogorical)	n	%	n	%		
Not satisfied	1	16.7	2	33.3		
Satisfied	5	83.3	4	66.7		

Paired-t test, 2 tailed was used to test the differences between non-bathing and bathing nights. Significance level was set at 0.01 due to multiple comparisons.

Total sample size N=6

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