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(第二年)
研究成果報告(精簡版)

計 畫 類 別 ：個別型
計 畫 編 號 ：NSC 95-2314-B-040-026-
執 行 期 間 ：95 年 08 月 01 日至 96 年 10 月 31 日
執 行 單 位 ：中山醫學大學護理學系(所)

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報 告 附 件 ：出席國際會議研究心得報告及發表論文

處 理 方 式 ：本計畫涉及專利或其他智慧財產權，1 年後可公開查詢

中 華 民 國 97 年 05 月 12 日

泡腳對居家老年人體溫與睡眠之成效探討(第二年)

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，使用隨機交叉設計，檢測睡前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。43位個案報名，25位個案(睡眠障礙=17,無主訴者=8) 完成此研究。核心體溫、腹溫、足溫與DPG溫度在泡腳晚高於無泡腳晚；無主訴睡眠障礙老人知這些溫度亦高於有睡眠障礙老人。不管是有無主訴睡眠障礙的老人，其PSG、actigraphy、與主觀睡眠品質在有無泡腳晚均無顯著差異。泡腳對主觀與客觀的睡眠均無影響。然而，睡眠潛伏期在泡腳的晚上有延長的趨勢，雖不顯著，但可能顯示睡前泡腳對老人家來說可能仍能提供熱能而使睡眠潛伏期延長。研究結果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 used a randomized crossover design to examine the effect of a warm footbath with 40°C water temperature, 20 minute duration on body temperatures and sleep in older adults with and without self-reported sleep disturbances. Forty-three subjects responded to our flyer and 25 participants (with sleep disturbance=17, without sleep disturbance = 8) completed this study. Trends of core, abdominal, and foot temperatures, and DPG (distal-proximal-skin temperature gradient) were higher in bathing night than in non-bathing night, and were higher in good sleepers than in poor sleepers. However, there were no significant sleep changes in PSG, actigraphy-estimated sleep, and perceived sleep quality between non-bathing and bathing nights in both good and poor sleepers. Footbath before sleep onset has no effect on objective and subjective sleep outcomes. Moreover, sleep latency was prolonged in bathing night than in non-bathing night though not significant. This indicated that foot bathing before sleep onset may provide heat to older adults, hence prolong their sleep latency. Findings from this study provide information for managing sleep difficulty in older adults.

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

Experimental crossover design was used to examine the effect of foot bathing on distal-proximal body temperature gradient and sleep quality in older adults. 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

Forty-three healthy older adults were recruited from flyer. Those who have sleep apnea in the first night were excluded (n=9). Nine subjects withdrew. Twenty-five participants completed this study. They were aged 55 years old and above with a mean age of 58.2 years (SD=2.6). Seventeen 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 Morning Questionnaire (MQ) 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.

Actigraphy

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.

Morning Questionnaire (MQ)

The Morning Questionnaire (MQ) 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

Personal characteristics

Twenty-five participants aged 55 ~ 81 years old completed this study. Table 1 shows their personal characteristics. Majority of them were married, and had 9 years of education. Half of them were female. None of them had depression or anxiety, except one with poor sleep had an anxiety score over 11.

Table 1. Participants' Characteristics

	Good sleeper				Poor sleeper			
	M	*SD*	*Min*	*Max*	*M*	*SD*	*Min*	*Max*
Age, years	56.8	4.1	55.0	67.0	61.2	6.5	55.0	81.0
Depression [a]	3.0	2.6	1.0	8.0	3.5	2.3	0.0	7.0
Anxiety [a]	2.9	2.5	0.0	7.0	4.3	4.1	0.0	16.0
PSQI [b]	3.8	1.3	2.0	5.0	8.5	2.4	6.0	14.0

	n	%	n	%
Gender				
Female	5	62.5	8	47.1
Male	3	37.5	9	52.9
Marriage				
Widow	2	25.0	2	11.8
Married	6	75.0	15	88.2
Education				
< 6 years	0	0.0	4	23.5
6-9 years	2	25.0	7	41.2
>9 - <14 years	3	37.5	5	29.4
14-16 years	3	37.5	1	5.9

[a] Hospital Anxiety and Depression Scale

[b] Pittsburg Sleep Quality Index

Perceived habitual sleep

Participants were interviewed by the PSQI to assess their habitual sleep quality (Table 2). In good sleepers, most of them had over 6 hours of sleep, less than 30 minutes of sleep latency, and greater than 85% of sleep efficiency. All of them were satisfied with their sleep. In poor sleepers, most of them slept less than 6 hours, greater than 30 minutes of sleep latency, and less than 85% of sleep efficiency. More than half of them were not satisfied to their sleep. Total sleep time and sleep efficiency were significantly different between good and poor sleepers.

Table 2. Perceived sleep (PSQI)

	Good sleeper		Poor sleeper			
	n	%	*n*	%	*X2*	*p*
Total sleep time					13.56	0.004
>=7 hours	3	37.5	1	5.88		
6~6.9hours	3	37.5	2	11.76		
5~5.9hours	2	25.0	12	70.59		
<=4.9hours	0	0.0	2	11.76		
Sleep latency					3.00	0.392
<= 15 min	5	62.5	4	24		
16-30 min	3	37.5	4	24		
31-60 min	0	0.0	6	35		
>= 60min	0	0.0	3	18		

Wake after sleep onset (min)						
Sleep efficiency (%)					8.24	0.016
> 85%	8	100.0	7	41.18		
75~84%	0	0.0	4	23.53		
65~74%	0	0.0	6	35.29		
<65%	0	0.0	0	0.00		
Sleep quality					3.24	0.072
Not satisfied	0	0.0	8	47.10%		
Satisfied	8	100.0	9	52.9		

Body temperatures

During foot bathing

Figure 1 and 2 display core, abdominal, and foot temperatures during foot bathing time for good and poor sleepers, respectively. In good sleepers, there are no differences in core, abdominal, or foot temperatures for bathing and non-bathing day at the beginning of foot bathing. After footbath starts, foot temperature is increasing in the first 10 minutes then dropping, and core temperature also increase about 2℃ in the end of footbath (Figure 1). In poor sleepers, there are no differences in core, abdominal, or foot temperatures for bathing and non-bathing day at the beginning of foot bathing too. After footbath stars, foot temperature is increasing but core temperature goes steadying all over the foot bathing (Figure 2). Figure 3 shows DPG trend in bathing and non-bathing night between good (GS) and poor (PS) sleepers. DPG is increasing during bathing, and DPG in good sleepers is higher than that in poor sleeper.

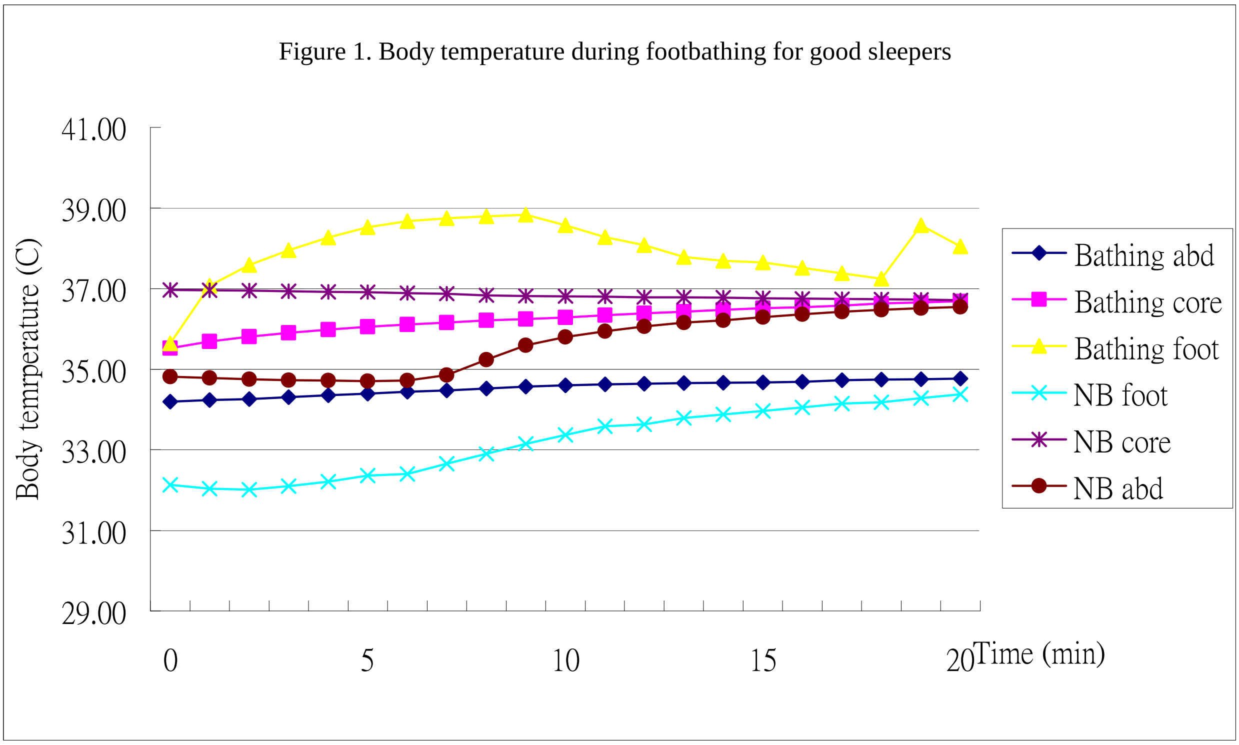


Figure 1. Body temperature during footbathing for good sleepers
Body temrperature (C)
41.00
39.00
37.00
35.00
33.00
31.00
29.00
0
5
10
15
20
Time (min)
Bathing abd
Bathing core
Bathing foot
NB foot
NB core
NB abd

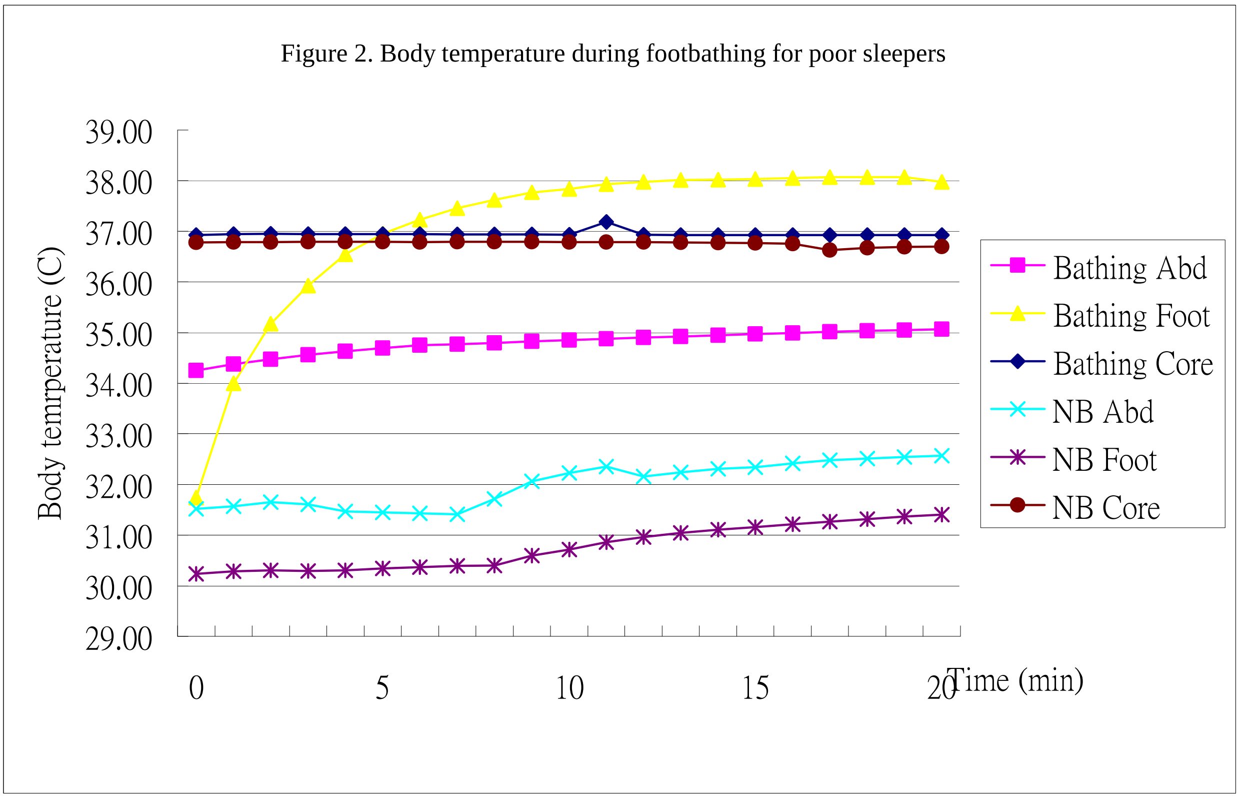
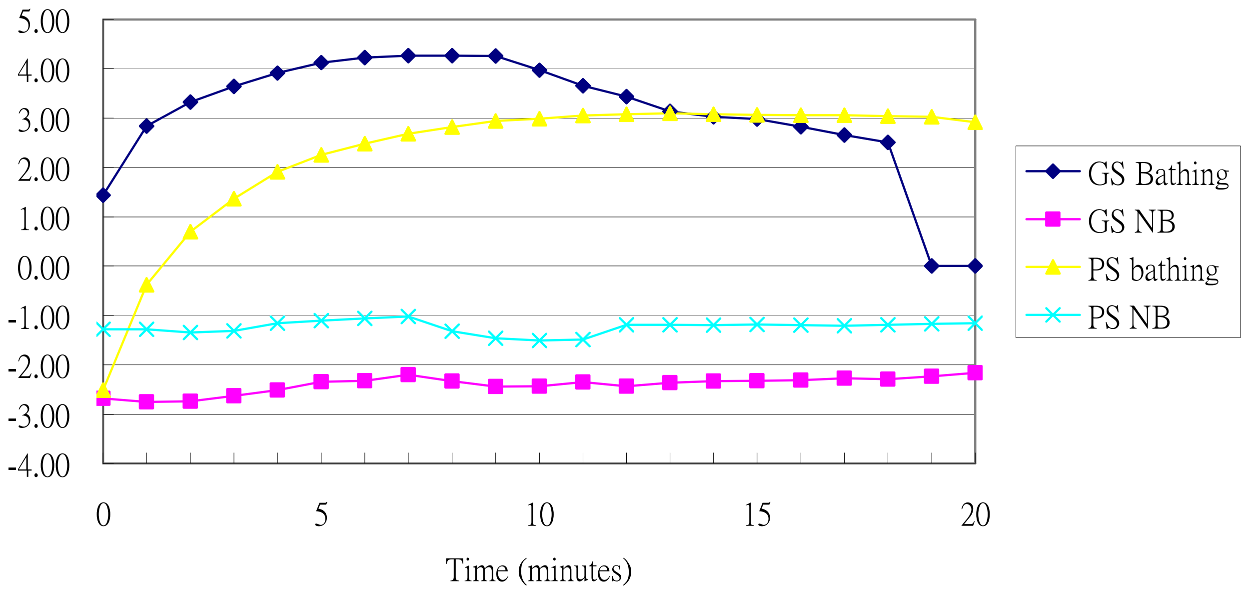


Figure 2. Body temperature during footbathing for poor sleepers
Body temrperature (C)
39.00
38.00
37.00
36.00
35.00
34.00
33.00
32.00
31.00
30.00
29.00
0
5
10
15
20
Time (min)
Bathing Abd
Bathing Foot
Bathing Core
NB Abd
NB Foot
NB Core

Figure 3. DPG during bathing



During sleep

Figure 4 & 5 shows core, abdominal, and foot temperatures during sleeping for good and poor sleepers, respectively. In good sleepers, there is no difference in core temperature for bathing and non-bathing night during sleeping. However, the trend of abdominal and foot temperature are higher in bathing night than non-bathing night at the first four hours of sleep (Figure 4). In poor sleepers, there is no difference in core temperature for bathing and non-bathing night during sleep. And abdominal and foot temperatures are higher in bathing night than non-bathing night at the first 4.5 hours of sleep (Figure 5). Figure 6 display DPG during sleeping for bathing and non-bathing night in good and poor sleepers. DPGs are higher in bathing night than in non-bathing night. DPGs in bathing night are increasing faster in the first 30 minutes of sleep in good sleepers than in poor sleepers..

Figure 4. Body temperature during Sleeping for good sleepers

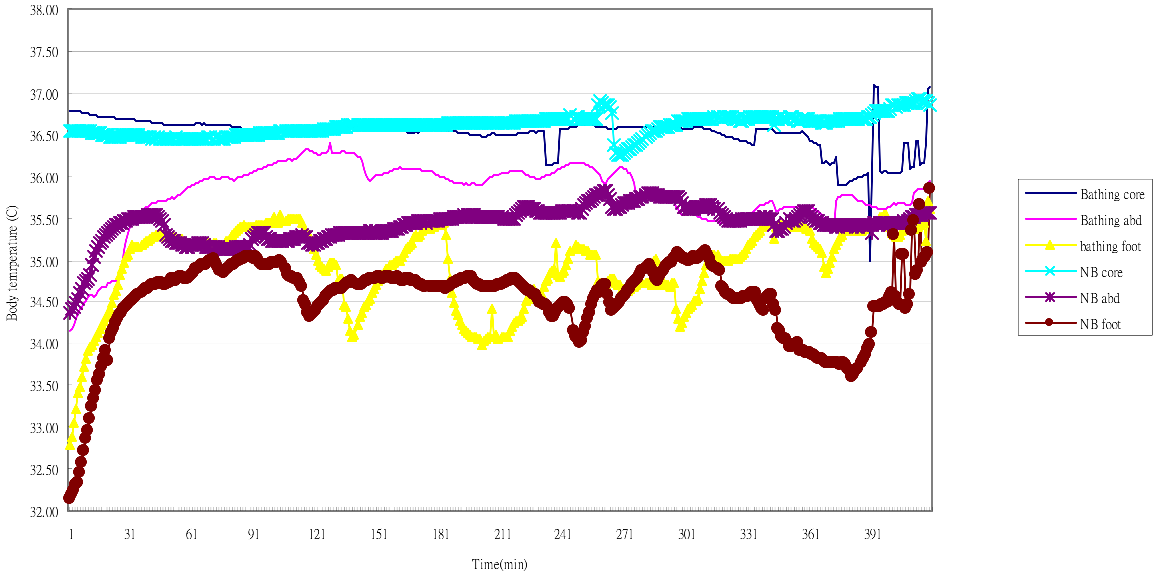
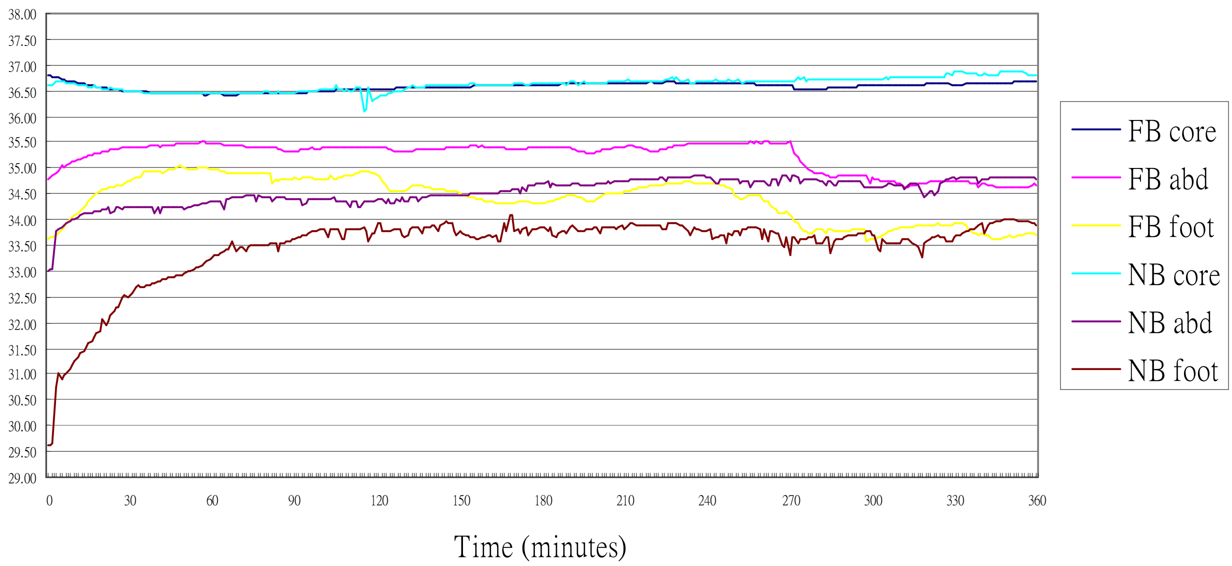
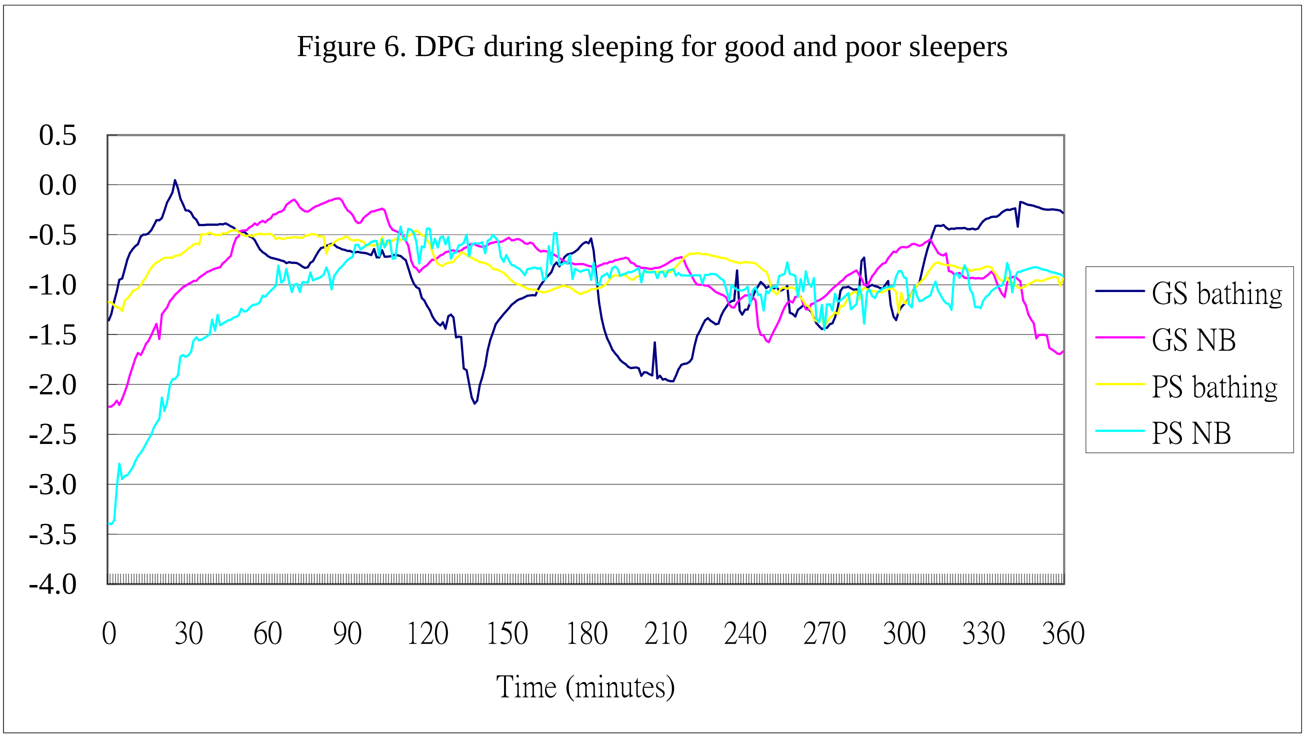


Figure 5. Body temperatures during sleeping for poor sleepers





Sleep

There are no differences in Polysomnography (PSG) and actigraphy-estimated sleep between bathing and non-bathing nights (Table 3). Moreover, there is no difference in perceived sleep quality between bathing and non-bathing nights (Table 4).

Table 3. Polysomnography and Actigraphy-estimated sleep between non-bathing and bathing nights

	Good sleeper (n=8)						Poor sleeper (n=17)					
	Non-bathing		Bathing				Non-bathing		Bathing			
	Mean	S.D.	Mean	S.D.	t	Sig	Mean	S.D.	Mean	S.D.	t	Sig
Polysomnography												
Total sleep time (min)	367.13	46.94	337.94	79.94	0.88	0.408	345.00	49.62	344.71	45.69	0.03	0.978
Sleep latency (min) (to stg 2)	7.13	7.91	18.56	31.70	-0.98	0.359	9.06	11.14	12.53	10.72	-0.88	0.393
Wake after sleep onset (min)	41.31	20.18	48.06	36.02	-0.38	0.713	50.71	31.71	47.53	26.08	0.39	0.703
Sleep efficiency (tst/tib) (%)	88.00	5.29	83.63	15.46	0.65	0.539	85.18	6.60	84.71	7.57	0.25	0.803
Sleep stages (% sleep period time)												
Stage 1	5.43	1.29	7.34	2.28	-2.09	0.075	7.19	5.03	6.75	3.60	0.45	0.657
Stage 2	55.59	13.11	55.35	8.56	0.04	0.967	53.32	10.98	56.05	6.04	-1.00	0.334
Stage 3	8.39	8.81	7.56	8.48	0.23	0.825	5.90	7.25	7.20	8.24	-0.68	0.509
Stage 4	1.33	2.47	0.04	0.11	1.51	0.176	2.36	5.40	0.14	0.35	1.76	0.098
SWS	9.71	9.95	7.60	8.52	0.58	0.577	8.26	11.32	8.03	10.61	0.35	0.733
REM	19.19	3.62	17.16	4.17	1.05	0.329	18.54	6.67	18.12	6.32	0.22	0.831
Actigraphy sleep												
Total sleep time (min)	368.43	48.85	354.14	58.18	0.80	0.457	356.75	43.91	356.56	47.92	0.02	0.982
Sleep latency (min)	9.29	8.77	14.14	21.21	-0.50	0.637	10.50	11.16	15.81	29.75	-0.83	0.420
Wake after sleep onset (min)	24.71	11.47	29.14	12.81	-1.56	0.169	23.56	10.39	21.56	9.01	1.18	0.257
Sleep efficiency (%)	88.37	2.95	86.29	9.35	0.52	0.624	89.19	356.75	87.43	7.58	1.22	0.241

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.

Table 4. Perceived sleep between non-bathing and bathing nights

	Good sleeper (n=8)						Poor sleeper (n=17)					
	Non-bathing		Bathing				Non-bathing		Bathing			
	Mean	S.D.	Mean	S.D.	t	Sig	Mean	S.D.	Mean	S.D.	t	Sig
Perceived sleep (MQ)												
Total sleep time (min)	365.00	68.24	322.50	94.53	1.20	0.270	347.65	67.13	335.29	64.72	0.66	0.519
Sleep latency (min)												
Wake after sleep onset (min)	1.00	0.53	1.38	0.92	-1.16	0.285	1.82	1.42	2.00	1.46	-0.53	0.605
Sleep efficiency (%)												
Sleep quality(1 to 10)	8.50	0.53	7.25	2.19	1.53	0.170	7.41	1.12	7.47	1.18	-0.16	0.875
Sleep satisfaction (scale)	8.50	0.53	7.00	2.14	1.87	0.104	7.71	1.05	7.47	1.28	0.64	0.533
Satisfaction (categorical)	n	%	n	%			n	%	n	%		
Not satisfied	0	0	1	12.5			1	5.88	2	11.76		
Satisfied	8	100	7	87.5			15	88.2	15	88.2		
missing							1	5.88	0	0		

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.

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出席國際會議研究心得報告與發表論文

The 21st annual meeting of the Associated Professional Sleep Societies (APSS).

Minneapolis, U.S.

廖玟君 Wen-Chun Liao

這是全世界最大的睡眠會議，報告者來自歐美亞澳非等五大洲，分享各自國家與個人在睡眠不同領域上的努力，議題涵括睡眠從出生到老年、婦女、健康者與有疾病者的睡眠議題。有好幾場的 speaker 都是睡眠各領域的大師，他們分享了他們在數年的睡眠研究領域中的成果，包括失眠議題、睡眠剝奪對人類思考對兒童發展的影響等等，除了在內容上收穫充分外，也給我很大的啟發，他們如何設計一個又一個的研究，解決一個又一個的疑問，以最大的好奇與無與倫比耐心與毅力，投注於睡眠議題的研究，這也是值得大家學習的地方。

APSS 會議的另一項特色是 Poster 都很值得看，作者也都在固定的時間為大家講解。一連數天我除了聽演講就是去看 poster，由於 poster 每天換，所以整個行程排的滿滿的，每天都有新刺激，大略了解目前睡眠領域的趨勢，收穫滿囊。在我的 poster session 有一位也可能是做 path analysis 的學者，不僅問我很多問題，也帶他的學生一直來”欣賞”我的 poster，讓我受寵若驚。我想我的眼光還是不錯的，挑了好的議題做了好的分析，而那分析方法也是目前很夯的方法。

除了整個議程收穫外，也發現了一團來自於台灣的團隊，那是政大楊建銘老師所帶領的學生團，包括大學生與研究生，他們有人是有報告，有人是出來增廣見聞的，有報告的團費有些補助，有些則完全自費，但可以在老師的帶領之下出來增廣見聞，我的感覺是很棒，希望當我有能力時我也可以如此帶領學生。

發表論文:

A Conceptual Model of Sleep Quality in Older Adults Living in the Community

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Introduction: Poor sleep is a common complaint among elders and often has impact on an individual's quality of life.

Methods: To investigate how personal, physical, psycho-social and environmental dimensions are related to the overall sleep quality, a cross-sectional design with face-to-face interview was conducted in community dwelling elders (N=259, mean ages 76.0±6.4 years) by using the Pittsburgh Sleep Quality Index (PSQI), the Hospital Anxiety and Depression Scale (HADS), the Ford Insomnia Stress Response Test (FIRST), and the Barthal Activity of Daily Living (ADL) Index. A conceptual framework and bivariate correlations guided a series of multiple regressions to identify the best predictors for sleep quality.

Results: Most of subjects were male (59.5％), lived with spouse and offspring (68.0％), had at least one kind of chronic disease but in stable condition (92.3%), and can perform ADL independently (88.4％). The leading exercise and leisure activities were walking (60.2％) and watching TV (52.5％), respectively. However, only 28.6％ of them had regular exercise. Mean global PSQI score was 7.5±4.2, and 60.6% of subjects were identified as poor sleepers (PSQI>5). Variation of perceived sleep quality among individuals was high. Anxiety (beta=.377), depression (beta=.252) (psychological dimension), disease numbers (beta=.166) (physical dimension), noise (environmental dimension), napping (beta=.114), leisure activities (beta=-.123), exercise (.094) (social dimension) and ADL (beta=.095) (physical dimension) were the best predictors for sleep quality, which accounted for 45.5% of variance of sleep quality in old adults living in the community. Conclusion: This conceptual model of sleep quality provides a comprehensive framwork for managing sleep in community dwelling elders. Health providers can enhance sleep quality for the elderly by facilitating their ADL status, social activities, mental well-beings, and sleep environment.

Key words: Sleep quality, older adults, model.