Received: 22 April 2019 | Revised: 5 December 2019 | Accepted: 20 December 2019

DOI: 10.1111/jjns.12327

ORIGINAL ARTICLE

JAPAN JOURNAL OF NURSING SCIENCE

WILEY

Effect of a hand massage with a warm hand bath on sleep and relaxation in elderly women with disturbance of sleep: A crossover trial

Yukiko Kudo | **Makiko Sasaki**

Department of Basic Nursing, Akita University Graduate School of Health Sciences, Akita, Japan

Correspondence
Yukiko Kudo, Department of Basic Nursing, Akita University Graduate School of Health Sciences, 1-1-1 Hondo, Akita City, 010-8543, Japan.
Email: yukiko@hs.akita-u.ac.jp

Funding information
Japan Society for the Promotion of Science, Grant/Award Number: 17K12073

[The copyright line for this article was changed on 27 July 2020 after original online publication]

Abstract

Aim: The purpose of the present study was to clarify the effects of a hand massage with a warm hand bath on sleep, autonomic nervous activity, subjective sleep quality, and relaxation in elderly women with sleep disturbance.

Methods: A crossover design was used. Participants were assigned to two groups: a structured control first and intervention second condition, or an intervention first and control second condition. The sleep index as assessed by actigraphy, autonomic nervous activity, subjective sleep quality, and relaxation was then recorded.

Results: The mean age of the participants was 77.8 ± 6.8 years (n = 28). According to the actigraph, the intervention day showed significantly improved sleep efficiency (p = .048) and sleep onset latency (p = .015). Regarding autonomic nervous activity, heart rate decreased significantly after the intervention (p = .001), but no significant differences were seen in the other indexes. Subjective sleep quality, which was investigated using the middle-age and aged version of the Oguri–Shirakawa–Azumi sleep questionnaire, was significantly higher after the intervention for four out of five factors. Subjective comfort and relaxation were significantly higher after the intervention for all items.

Conclusions: A hand massage with a warm hand bath in the evening improved sleep efficiency and sleep onset latency in elderly women with sleep disturbance. These results suggest that a hand bath and massage may improve subjective sleep quality and relaxation.

KEYWORDS

actigraph, aged women, autonomic nervous activity

1 | INTRODUCTION

It is commonly known that the sleep–wake rhythm in elderly people is likely to be disturbed, and that elderly people have shallower sleep than children and young adults (Kales & Kales, 1974). In previous surveys, about 29.5% of elderly people had insomnia (Kim, Uchiyama, Okawa, Liu, & Ogihara, 2000), and about 60% of the elderly had poor sleep quality (Eser, Khorshid, & Cinar, 2007). According to a meta-analysis on changes in sleep due to aging (Ohayon, Carskadon, Guilleminault, & Vitiello, 2004), sleep efficiency continued to significantly decrease after 60 years of age. The reason why sleep patterns vary with aging is that the amplitude of the biological rhythm decreases and the time zone of sleep becomes earlier (Teofilo, Cynthia, & Rita, 2009).

To treat sleep disorders, sleeping pills may be administered. However, drug administration is prone to increase the risks of deteriorated cognitive function and falling in elderly people (Mamun & Lim, 2009). Therefore, in the field of sleep promotion, reconsidering lifestyle-related factors is recommended to improve the sleep health of elderly people. It has been reported that taking a short nap, going for a walk, and engaging in light exercise in the evening helps elderly individuals maintain and improve their sleep health (Tanaka et al., 2000). Thus, it may be possible to maintain and promote the sleep health of the elderly with interventions focused on sleep rhythms and lifestyle factors, such as activity and rest levels, in everyday life. Foot bathing is a well-known nursing intervention aimed at improving sleep. In a blinded, randomized controlled trial of 46 elderly people, subjective sleep quality, sleep latency, and sleeping duration as assessed using the Pittsburgh Sleep Quality Index (PSQI) improved after a foot bath (Seyyedrasooli, Valizadeh, Zamanzadeh, Nasiri, & Kalantri, 2013).

Although the effects of foot baths on sleep have been reported, to our knowledge, no studies have examined the effects of hand baths that use warm water, the same as foot baths, on sleep. Hand baths are a nursing intervention that can be carried out more easily than foot baths, and have been shown to be capable of providing subjective comfort (Kudo et al., 2019). In addition, hand massages, which can be provided together with a hand bath, are known to provide comfort and relaxation. Massage therapy is described as the systematic manual rubbing, kneading, or stroking of body tissues with the hands to promote physiological effects that enhance well-being (Kolcaba, Schirm, & Steiner, 2006). Massages have been reported to reduce pain perception (Janssen, Shroff, & Jaspar, 2012; McCullough, Liddle, Close, Sinclair, & Hughes, 2018), blood pressure, and heart rate (Khaledifar, Nasiri, Khaledifar, Khaledifar, & Mokhtari, 2017; Lund, Lundeberg, Kurosawa, & Uvnäs-Moberg, 1999). On the other hand, massages have been reported to stimulate the human body because they increase cortisol levels (McCullough et al., 2018). Hand massages have been shown to have a comforting and relaxing effect (Kunikata, Watanabe, Miyoshi, & Tanioka, 2012; Sato, 2006) and to alleviate anxiety (Mei, Miao, Chen, Huang, & Zheng, 2017; Mobini-Bidgoli, Taghadosi, Gilasi, & Farokhian, 2017). However, to our knowledge, no study has been conducted to examine the effects of hand massages on sleep in older adults with sleep disturbance. Therefore, we aimed to verify the effects of hand massages on sleep by improving circulation in the hand with a hand bath before the hand massage. Hand baths and massages provide comfort to the subject, and it has been speculated that hyperthermia and massage stimulation affect circulatory dynamics and autonomic nervous activity. The changes in sleeping rhythms that accompany aging are often caused by changes in lifestyle, so lifestyle improvements are also recommended. Therefore, it may be possible to improve sleep quality and sleep onset latency through interventions consisting of hand baths and hand massages corresponding to light exercise in the evening. With this background, the purpose of the present study was to clarify the effects of a hand massage with a warm hand bath on sleep, autonomic nervous activity, subjective sleep quality, and relaxation in elderly women with sleep disturbance.

2 | METHODS

2.1 | Study design

The present study utilized a crossover design using an intervention that consisted of a warm hand bath and a hand massage. The study participants were assigned to two groups: a structured control first and intervention second condition (Group A, Figure 1), or an intervention first and control second condition (Group B, Figure 1). This study was registered at the Japan Primary Registries Network, UMIN-CTR (trial number, UMIN000027525). The first participant was enrolled on September 19, 2017.

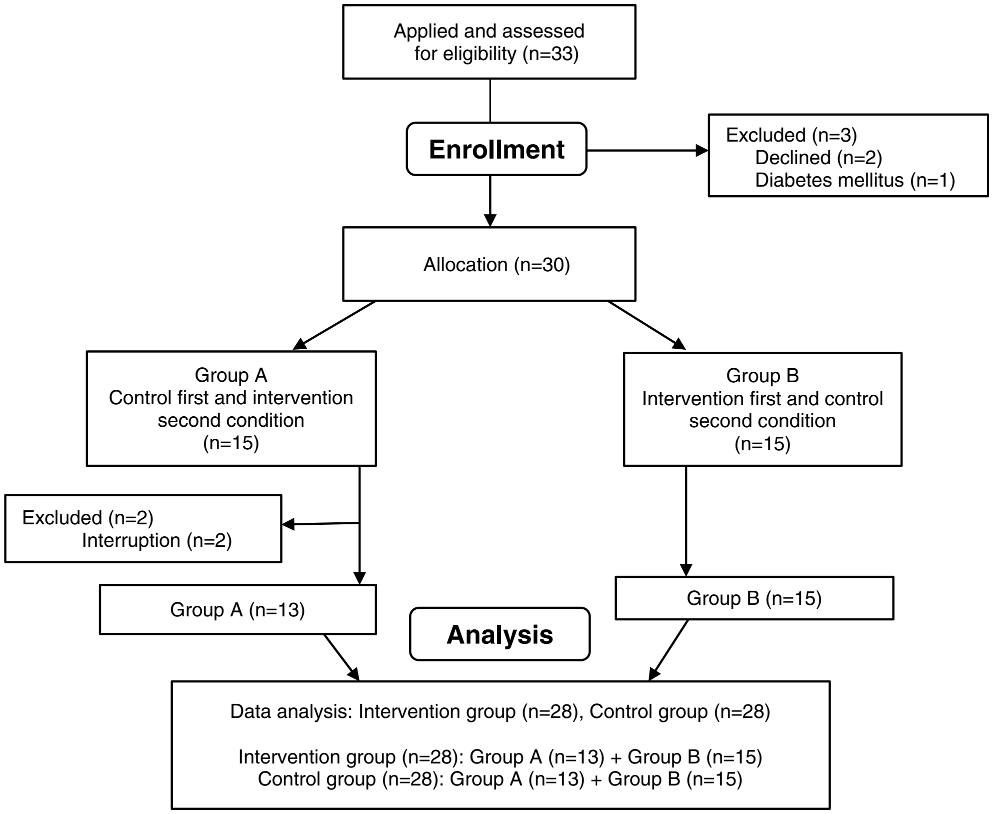
2.2 | Ethical considerations

This study was carried out in accordance with the Declaration of Helsinki and was approved by the Independent Ethics Committee at Akita University Graduate School of Medicine. Before the study began, the protocol and procedures were explained, and written informed consent was obtained from all participants. All personal information was kept strictly confidential.

2.3 | Participants

The study participants were elderly women aged 65 years or older living independently in the Tohoku region of Japan. The reason for including only women was to exclude the possibility of any gender-based differences. The sample size was calculated based on sleep efficiency resulting from actigraph readings, which were the primary outcome. Prior data (Haimov & Shatil, 2013) indicated that differences in the mean response of matched pairs are normally distributed, with a standard deviation (SD) of 12.56. If the true difference in the mean response of matched pairs is 6.74, then 29 pairs of participants

FIGURE 1 Flow diagram of the present study



need to be studied to be able to reject the null hypothesis that the response difference is 0 with a probability (power) of .8. The type I error probability associated with the test of this null hypothesis is .05. Therefore, we aimed to recruit 30 participants for the final analysis.

We excluded cases with a medical history of conditions such as diabetes, because diabetes has been reported to be associated with autonomic nervous activity (Nayak, Acharya, Jain, & Lenka, 2013) and sleep disorders (Reichmuth, Austin, Skatrud, & Young, 2005). We posted outlines of the present study to bulletin boards at some social welfare facilities and the local handicraft club, and then explained the study purpose and methods to those who showed interest. In total, 33 elderly women showed intention to participate in the study. After excluding those who had a medical history of conditions such as diabetes, 30 women were assessed further for eligibility. Figure 1 shows the flow of the participants through the trial.

2.4 | Measures

2.4.1 | Characteristics of the participants

All participants provided the following information regarding their background characteristics: age, body mass index, history of smoking and drinking, regular exercise habits, medication, sleeping environment, and prevalence of constipation, which affects sleeping and autonomic nervous activity. The participants' sleep habits were examined using the PSQI. The PSQI (Buysse, Reynolds III, Monk, Berman, & Kupfer, 1989) is a self-rated measure of sleep quality that assesses subjective sleep quality, sleep onset latency, sleep time, sleep efficiency, sleep disturbances, hypnotic drug usage, and daytime dysfunction. In the present study, we used the Japanese version of the PSQI (PSQI-J; Doi et al., 2000). Possible scores on the PSQI-J range from 0 to 21, with higher scores indicating worse sleep quality. An overall PSQI score ≥ 6 can be used to identify sleep problems. In the study by Doi et al., the overall Cronbach's alpha was .77 in all participants. Based on the PSQI-J screening, all participants in the present study were classified as poor sleepers (PSQI-J ≥ 6).

2.4.2 | Actigraphy

We used an actigraph (Ambulatory Monitoring, Ardley, NY, USA), which senses motion as acceleration, placed on the wrist of the nondominant arm to measure sleep quality. Standard criteria were used to identify the onset and offset of sleep periods with a built-in algorithm. The obtained data were stored in the device memory and based on clock time. Actigraph measurement data and sleep polygraphs are strongly correlated (Shinkoda, Park, & Matsumoto, 1998). Actigraphs can be worn without causing distress because they are similar to a wristwatch. Actigraph data were downloaded to a computer using a special interface unit. The Cole–Kripke algorithm (Cole, Kripke, Gruen, Mullaney, & Gillin, 1992) was used in Action-W software (version 2.7.3045; Ambulatory Monitoring) to score each epoch as sleep or wake. The measurement index of the actigraph consisted of time in bed (TIB, min), total sleep time (TST, min), wake time after sleep onset (WASO, min), sleep efficiency (SE, %), sleep onset latency (SL, min), number of awakenings (NA, times), activity index at bedtime (ACTI, %), activity during daytime (activity mean, score), and naps during daytime (sleep episode, times). Daily sleep logs, bedtimes, and wake times were taken from the sleep logs that were maintained by the participants. The actigraphs were attached to the participants all day during the data collection period. Sampling was performed on the intervention day and the control day.

2.4.3 | OSA-MA

To evaluate the sleeping feeling when waking up, the middle-age and aged version of the Oguri–Shirakawa–Azumi sleep questionnaire (OSA-MA) was used. The OSA-MA (Yamamoto, Tanaka, Takase, & Shirakawa, 1999) is a self-report questionnaire that is useful for middle-age and old-age individuals. It is composed of 16 adjectives with responses rated on a scale from 0 to 3 that can be consolidated into five factors: “sleepiness on rising”, “initiation and maintenance of sleep”, “frequent dreaming”, “refreshing”, and “sleep length”. In Yamamoto's study (1999), the overall Cronbach's alpha was .81. A high OSA-MA subscale score indicates a better sleep state. Sampling was performed on the intervention day and the control day.

2.4.4 | Autonomic nervous activity

Autonomic nervous activity was analyzed based on heart rate (HRT) variability according to time- and frequency-domain analyses. HRT, the SD of the normal-to-normal interval (SDNN), and the root-mean-square of successive differences of the NN interval (RMSSD) were adopted in the time-domain analysis. A reduction in HRT is considered one of the indexes of relaxation. Further, SDNN is strongly correlated with overall fluctuations, RMSSD is associated with parasympathetic nervous activity, and reductions in SDNN and RMSSD are interpreted as decreases in parasympathetic activity (Task Force of the European Society of Cardiology, the North American Society of Pacing Electrophysiology, 1996). In the frequency-domain analysis, a high frequency (HF) component with a frequency band of 0.15–0.4 Hz and a low frequency (LF) component with a frequency band of 0.04–0.15 Hz were used. HF reflects the parasympathetic nervous tone caused by natural respiration, and the ratio of LF to HF (LF/HF ratio) indicates the balance between sympathetic and parasympathetic tones (Paul & Vaschillo, 2003). In the present study, HRT variability was examined using the Pulse Analyzer Plus View (TAS9VIEW; YKC Corporation, Tokyo, Japan), which is a device that depicts a change in the volume of a peripheral blood vessel as a pulse wave, extracts a pulse, and then analyzes autonomic nervous activity. The pulse measurement accuracy is ±2 bpm and the pulse wave measurement accuracy is ±5%. Photoplethysmography data were recorded using a probe clipped to the index finger of the left hand. HRT variability was measured for 5 min in each participant. HRT, SDNN, RMSSD, HF, and LF/HF were sampled before and after the intervention.

2.4.5 | Subjective comfort and relaxation

Three items, “Feel good”, “Warm”, and “Sleepy” were established using a 10-cm visual analog scale (VAS), with high values indicating high comfort. The subjective indexes “Feel good”, “Warm”, and “Sleepy” were an indicator of comfort based on a foot massage study conducted by Igusa et al. (2008) and a tactile care study conducted by Koizumi et al. (2012).

Next, relaxation was evaluated using a revised version of the Rating Scale of Emotion as defined in terms of relaxation (RE scale). Nedate and Agari (1984) developed this scale as a measurement of the subjective sense of relaxation, which was then revised by Takahashi (1996) to decrease the item representation. The RE scale is composed of four items: from “feel high” to “feel at ease”, from “feel tension in the body” to “feel loose”, from “feel anxious” to “feel relieved”, and from “feel straitjacketed” to “feel expansive”. The response categories range from 0 to 10, with higher scores indicating greater relaxation. Takahashi (1996) reported that the instrument had acceptable reliability (Cronbach's alpha, .81–.87). The VAS and RE scale were sampled before and after the intervention.

2.5 | Intervention and procedures

The study period was from September 2017 to December 2018, excluding severe winter and summer periods. The intervention was carried out in the evening between 15:00 and 18:00 hours. The reason for carrying out the intervention between 15:00 and 18:00 hours is that the participants started to eat dinner at 18:00 hours, after which, they began to prepare for bathing and going to bed, which they did by around 20:00–21:00 hours. We also considered the impact of light exercise in the evening, which is recommended to improve sleep (Tanaka et al., 2000). With these observations, we decided to implement an intervention protocol. The study environment had a constant room temperature of 25.0 ± 1.1°C and relative humidity of 59.1 ± 5.6%. All participants wore casual wear and raised their sleeves to the elbow at the time of the intervention. We instructed the participants to carry out their normal activities of daily living without changing their daily schedules, including exercise, bathing, and meals.

The participants were given hand baths while resting in a seated position. First, participants were given a warm hand bath (water temperature in the basin: 39–40°C, 2 L) for 5 min. Their hands and forearms were immersed up to the radial styloid process without massaging. Second, they were given a hand massage for 20 min. The hand massage technique was acquired by the researchers through training from the Japanese Hand Therapist Certification Association. The intervention started from the participant's ventral side of the left hand and proceeded as follows: massage of the forearm (60 s), massage from the wrist to the finger (90 s), pulling and extension of the fingers (60 s), massage of all fingers (60 s), massage of the inside of the hypothenar (60 s), massage of the wrist (60 s), and the application of pressure to the center of the palm (30 s). Next, the massage was continued on the dorsal side of left hand as follows: massage from the wrist to the finger (60 s), massage of all fingers (60 s), and massage of the wrist (60 s). The same process was then repeated on the right hand. A massage cream was used (2 g of fragrance-free Ciel Massage Cream®; WORLDJB Co., Ltd., Tokyo, Japan).

According to the study protocol, the participants were required to undergo investigation for 6 days. On the first day, the participants were screened using the PSQI-J, asked to provide written informed consent, and then were allocated. Next, we structured the control first and intervention second condition every 2 days (Group A), or the intervention first and control second condition every 2 days (Group B). Actigraphs were provided to the participants to wear throughout the day. If the actigraphs were removed during bathing, the participants were asked to note this in a sleeping diary. On the sixth day, the actigraph was removed. Before and after the intervention, researchers measured autonomic nervous activity for 5 min using TAS9VIEW and participants completed the VAS and RE scale. In addition, participants filled in the OSA-MA every morning.

2.6 | Statistical analysis

For the analysis, data from the second day were used for both the intervention day and the control day. First, an unpaired t test was conducted to confirm the presence of a carryover, treatment, or period effect caused by the crossover design. No outcomes displayed evidence of a significant carryover, treatment, or period effect ($p = .767$, $p = .478$, $p = .057$, respectively).

Next, the results of the actigraph, OSA-MA, autonomic nervous activity, and VAS were investigated using the Kolmogorov–Smirnov test to confirm the normality of the data. HF and LF/HF were converted to natural logarithms. The actigraph, OSA-MA, and VAS scores were analyzed using a paired t test. Autonomic nervous activity and RE scale scores were analyzed using the Wilcoxon signed-rank test. The participants ranged in age from 66 to 90 years, so we calculated age-adjusted correlation coefficients between changes in autonomic nervous activity indexes and the VAS and RE scale. Each test was considered a separate analysis, with significance set at $p < .05$. The data for each variable were presented as mean ± SD or median (25th, 75th percentile). SPSS (ver. 22J; SPSS Institute Japan, Tokyo, Japan) was used for all data analysis.

3 | RESULTS

A total of 30 participants were assigned to either the structured control first and intervention second condition (Group A), or the intervention first and control second condition (Group B) in a crossover trial (Figure 1). Two participants in Group A for whom the intervention was interrupted were subsequently excluded, leaving 28 participants each in the intervention and control groups.

3.1 | Demographic characteristics

The mean age of the participants was 77.8 ± 6.8 years (range, 66–90). The characteristics of the participants are shown in Table 1. The Pearson correlation coefficient of age and PSQI-J score was $r = -.010$ ($p = .959$). No correlation was observed between age and PSQI-J score.

3.2 | Actigraph

Table 2 shows the results of the comparison between the intervention and control days for the actigraph. The intervention day showed significantly higher SE (90.2 ± 7.5% vs 88.6 ± 6.9%; $p = .048$), and significantly shorter

TABLE 1 Demographic characteristics of the 28 participants

		Mean (SD)
Age, years		77.8 (6.8)
Body mass index, kg/m^2		22.1 (3.4)
PSQI-J score		9.2 (2.9)
Room temperature, °C		25.0 (1.1)
Room humidity, %		59.1 (5.6)
	Yes *n* (%)	**No *n* (%)**
History of smoking	1 (3.6)	27 (96.4)
History of drinking	1 (3.6)	27 (96.4)
Regular exercise	24 (85.7)	4 (14.3)
Constipation	9 (32.1)	19 (67.9)
Stiff shoulder	17 (60.7)	11 (39.3)
Lumbago	20 (71.4)	8 (28.6)
Arthralgia	13 (46.4)	15 (53.6)
Use of sleeping pills	12 (42.9)	16 (57.1)
Sleeping in the same room	1 (3.6)	27 (96.4)
Lights off during sleep	20 (71.4)	8 (28.6)
Bath time/after intervention	17 (60.7)	11 (39.3)

Note: $N = 28$.
Abbreviations: PSQI-J, Japanese version of the Pittsburgh Sleep Quality Index; SD, standard deviation.

SL (6.5 ± 2.5 min vs 8.0 ± 3.0 min; $p = .015$). No differences in TIB, TST, WASO, NA, ACTI, activity mean, or sleep episode were observed.

3.3 | OSA-MA

The intervention day showed significantly higher values for factors 1–4, but no significant difference was found in the sleep length for factor 5 (Table 2).

3.4 | Autonomic nervous activity

No significant differences were observed between the data at baseline and before the intervention, so the Wilcoxon signed-rank test was performed before and after the intervention. The data are presented as median (25th, 75th percentile). The results showed that HRT decreased significantly after the intervention, 71.5 (64.3, 79.3)/min versus 68.0 (62.5, 76.5)/min ($p = .001$). However, no significant differences were observed in SDNN: 38.1 (26.3, 60.4) ms versus 35.6 (24.1, 67.8) ms ($p = .900$), RMSSD: 37.5 (18.3, 74.0) ms versus 28.5 (22.3, 83.0) ms ($p = .624$), HF: 5.1 (3.7, 6.4) versus 4.6 (3.5, 5.7)

TABLE 2 Comparison of actigraph and OSA-MA results between the intervention day and control day in the 28 participants

	Intervention day, mean (SD)	Control day, mean (SD)	95% CI	*t*	*p*
Actigraph					
Time in bed, min	473.6 (101.6)	481.1 (100.2)	[−38.5, 23.5]	−.496	.624
Total sleep time, min	464.0 (103.3)	460.1 (97.0)	[−26.6, 34.4]	.264	.793
Wake time after sleep onset, min	43.4 (30.0)	49.3 (25.1)	[−13.6, 1.77]	−1.581	.126
Sleep efficiency, %	90.2 (7.5)	88.7 (6.9)	[.01, 3.11]	2.068	**.048**
Sleep onset latency, min	6.5 (2.5)	8.0 (3.0)	[−2.62, 0.31]	−2.604	**.015**
Number of awakenings	2.9 (2.2)	3.1 (1.7)	[−0.89, .39]	− .803	.429
Activity index at bedtime, %	23.5 (8.9)	22.3 (7.9)	[−1.60, 4.03]	.884	.384
Activity at daytime, score	177.0 (32.6)	174.1 (38.2)	[−4.66, 10.5]	.790	.436
Naps during daytime	4.5 (3.2)	5.3 (4.7)	[−2.15, 0.51]	−1.265	.217
OSA-MA score					
Factor 1: Sleepiness on rising	53.9 (8.7)	48.0 (10.8)	[2.79, 9.06]	3.882	**.001**
Factor 2: Initiation and maintenance of sleep	49.7 (9.7)	39.9 (13.3)	[6.20, 13.3]	5.636	**.000**
Factor 3: Frequent dreaming	55.9 (6.5)	51.5 (11.5)	[1.72, 7.06]	3.376	**.002**
Factor 4: Refreshing	53.8 (8.0)	48.5 (10.4)	[2.03, 8.59]	3.323	**.003**
Factor 5: Sleep length	51.6 (9.0)	47.9 (12.6)	[− .16, 7.65]	1.967	.060

Notes: $N = 28$; data are presented as mean (SD) unless otherwise indicated; paired *t* test; bold values indicate significant differences.
Abbreviations: OSA-MA, Oguri–Shirakawa–Azumi sleep questionnaire, middle-age and aged version.

TABLE 3 Comparison of visual analog scale and Rating Scale of Emotion as defined in terms of relaxation (RE) scores before and after 25-min hand massage with a warm hand bath in the 28 participants

	Before, mean (SD)	After, mean (SD)	95% CI	*t*	*p*
Visual analog scale					
Feel good	41.7 (20.0)	84.0 (7.2)	[−49.2, 35.4]	−12.60	**.000**
Warm	35.8 (21.2)	81.8 (10.4)	[−53.8, 38.2]	−12.11	**.000**
Sleepy	15.9 (17.0)	54.0 (21.2)	[−47.7, 28.4]	−8.08	**.000**
	Before, median (25th, 75th percentile)	After, median (25th, 75th percentile)		z	*p*
RE scale					
Factor 1: "Feel high" to "feel at ease"	6.0 (5.0, 7.0)	9.0 (8.0, 9.0)		−4.622	**.000**
Factor 2: "Feel tension in the body" to "feel loose"	6.0 (6.0, 7.0)	9.0 (8.0, 9.0)		−4.678	**.000**
Factor 3: "Feel anxious" to "feel relieved"	6.5 (6.0, 8.0)	9.0 (9.0, 10.0)		−4.410	**.000**
Factor 4: "Feel straitjacketed" to "feel expansive"	6.0 (6.0, 7.8)	9.0 (8.0, 9.0)		−4.444	**.000**

Notes: Above; $N = 28$; data are presented as mean (SD); visual analog scale scores were analyzed by a paired *t* test; bold values indicate significant differences. Below; $N = 28$; Data are presented as median (25th, 75th percentile); RE scale scores were analyzed by the Wilcoxon signed-rank test; RE scale, relaxation was evaluated using a revised version of the rating scale of emotion as defined in terms of relaxation; bold values indicate significant differences.

TABLE 4 Age-adjusted correlation coefficients (*r*) between changes in autonomic nervous activity indexes and visual analog scales and Rating Scale of Emotion as defined in terms of relaxation (RE) in the 28 participants

	HRT		SDNN		RMSSD		HF		LF/HF	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Visual analog scale										
Feel good	−.244	0.22	−.103	0.609	−.328	0.095	−.185	0.356	0.056	0.783
Warm	0.062	0.759	0.098	0.626	−.116	0.565	−.142	0.479	0.111	0.582
Sleepy	0.098	0.626	0.207	0.301	**0.436**	**0.023**	**0.509**	**0.007**	−.338	0.084
RE scale										
Factor 1: "Feel high" to "feel at ease"	−.339	0.078	−.270	0.164	−.086	0.665	0.09	0.648	0.063	0.751
Factor 2: "Feel tension in the body" to "feel loose"	−.326	0.09	−.035	0.86	0.151	0.444	**0.412**	**0.03**	−.006	0.977
Factor 3: "Feel anxious" to "feel relieved"	**−.404**	**0.033**	−.047	0.812	−.212	0.279	0.058	0.77	0.159	0.418
Factor 4: "Feel straitjacketed" to "feel expansive"	−.368	0.054	0.236	0.227	0.058	0.769	0.323	0.094	0.169	0.391

Notes: $N = 28$; bold values indicate significant differences.
Abbreviations: HF, high frequency; HRT, heart rate; LF/HF, low frequency/high frequency; RMSSD, root-mean-square of successive differences of the normal-to-normal interval; SDNN, standard deviation of the normal-to-normal interval.

($p = .439$), or LF/HF: 1.1 (1.0, 1.2) versus 1.1 (0.9, 1.3) ($p = .649$).

3.5 | Subjective comfort and relaxation

The scores for all items on the VAS and RE scale were significantly higher after comparing with before the intervention (Table 3).

3.6 | Age-adjusted correlation coefficients between changes in autonomic nervous activity indexes and subjective comfort and relaxation

A significant positive correlation was observed between "Sleepy" on the VAS and RMSSD ($r = .436$, $p = .023$) and HF ($r = .509$, $p = .007$) (Table 4). A significant positive correlation was observed between HF ($r = .412$, $p = .030$)

and RE scale factor 2. A significant negative correlation was observed between HRT ($r = -.404$, $p = .033$) and RE scale factor 3.

4 | DISCUSSION

4.1 | Effects of hand massage with a warm hand bath on sleep

Hand massage with a warm hand bath did not appear to affect sleeping time because no significant differences in TIB, TST, WASO, or factor 5 of the OSA-MA were found in the comparison between the intervention day and the control day. On the other hand, SE was significantly higher, SL was significantly shorter, and factor 2 of the OSA-MA was significantly higher on the intervention day than on the control day. From the above, it was suggested that a hand massage with a warm hand bath performed in the evening may improve sleep efficiency and sleeping. In a previous study that examined the effects of a hand massage on sleep in individuals with sleep disturbance, sleep efficiency was higher during periods with than without a massage; however, the reason for this was unclear (Imanishi, Watanabe, Watanabe, Sakurada, & Onouchi, 2010). In addition, in acupressure research, sleep efficiency and SL on a subscale of the PSQI were reported to have improved in the intervention group (Chen, Lin, Wu, & Lin, 1999); however, the physiological mechanism remained unclear because only the effect of the acupressure stimulation was considered. Thus, in previous research, the effects of a hand massage with a warm hand bath on sleep efficiency and SL were not reported in detail. The improvement of sleep efficiency and SL was considered to be related to the change in body temperature, because "Warm" and "Sleepy" had significantly higher VAS scores in the present study. The relationship between sleep and body temperature was also clarified in a previous study. Specifically, there is a mechanism in which the local skin temperature increases and the deep body temperature decreases (Uchiyama et al., 2000), and sleep is known to occur at a time when the body temperature is low (Tan et al., 2003). In this study, participants were asked to wear an actigraph and a Pulse Analyzer to clarify the effects of hand massage with a warm hand bath on sleep and autonomic nervous activity. However, wearing a device for measuring skin temperature was a limit considering the burden on participants. Therefore, it will be necessary to verify the influence of hand baths and massages on sleep from the viewpoint of body temperature in a future study.

In the results of the OSA-MA, four factors increased on the intervention day. This finding indicated that the intervention improved subjective satisfaction in terms of drowsiness when waking up, SL, and maintaining sleep. From the above, performing a hand massage with a warm hand bath in the evening could be expected to improve subjective feelings of sleepiness. In addition, the intervention may have led to a feeling of tiredness with comfort. This finding suggests that performing the hand massage with a warm hand bath intervention in the evening may correspond to the effect of light movement in the evening for promoting the maintenance of sleep health proposed by Tanaka et al. (2000).

4.2 | Effects of hand massage with a warm hand bath on autonomic nervous activity and subjective comfort and relaxation

In regard to autonomic nervous activity, a significant difference was observed only in HRT, which was significantly decreased after the intervention. A reduction in HRT is considered as one of the indexes of relaxation. Sato (2006), who carried out a hand massage intervention for healthy adult women, also reported a significant decrease in HRT. On the other hand, no differences in SDNN, RMSSD, HF, or LF/HF were observed in the present study. There are three possible reasons for this. First, although the aim of the present study was to collect data before and after the intervention, autonomic nervous activity was not measured during the intervention (25 min during the hand bath and massage). In a previous study (Kudo et al., 2018), although the level of parasympathetic nervous activity temporarily changed during hand bathing, it tended to change immediately after bathing and return to the standard value thereafter. Therefore, if autonomic nervous activity is recorded during the intervention, there may be a change due to the intervention. In that case, it is inappropriate to use an instrument that utilizes a finger pulse wave; rather, we think it is preferable to use a device that can take measurements using a pulse wave in an earlobe. Second, aging-related changes are reportedly most prominent in the parasympathetic nervous system, and sympathetic reactivity is also decreased (Japan Society of Neurovegetative Research, 2015). Since the mean age of the participants in the present study was 77.8 years, it is possible that autonomic nervous activity did not respond remarkably during the intervention. Third, it is conceivable that the hand massage with a warm hand bath carried out in the present study is an intervention method that can provide subjective relaxation without affecting autonomic nervous activity. As the VAS and RE scale were significantly higher after the intervention, a hand massage with a warm hand bath could be expected to provide subjective comfort and relaxation effects.

Further, we calculated age-adjusted correlation coefficients between changes in autonomic nervous activity indexes and the VAS and RE scale. As a result, a significant positive correlation was observed between "Sleepy" on the VAS and RMSSD and HF, and between HF and RE scale factor 2. This finding suggests that parasympathetic nervous activity was activated in the participants who felt "sleepy" or "loose." Further, a significant negative correlation was found between HRT and RE scale factor 3, which suggests that participants who felt "relieved" had decreased HRT. From the above, it seems possible that feeling subjective comfort and relaxation may be related to physiological effects. In the protocol of the present study, autonomic nervous activity was measured before and after the evening intervention, not continuously until sleep. Therefore, we could not consider the relation between sleep and subjective relaxation and autonomic nervous activity. In future research, it will be necessary to verify the causal relation between sleep and subjective relaxation and autonomic nervous activity.

4.3 | Recommendations for nursing interventions

A hand massage with a warm hand bath appears to improve sleep efficiency, SL, sleep quality, and comfort in elderly women with sleep disturbance. Taking a foot bath before going to bed has been a major intervention for improving sleep, but based on the results of the present study, an intervention involving a hand massage with a warm hand bath before dinner also appears to have a positive effect on sleep.

4.4 | Limitations

A few limitations to the present study must be noted. First, because the participants were recruited through postings on bulletin boards at social welfare facilities and at local handicraft clubs, there is a possibility of self-selection bias, in which those who wished to participate were those who were experiencing sleeping problems. However, this was likely not a problem because the purpose of the present study was to clarify the effects of an intervention on sleep in elderly women with sleep disturbances. Furthermore, it was difficult to control for history of hypertension, which is a factor affecting autonomic nervous activity. Second, the present study was not double-blind because a single researcher conducted the intervention; however, we were able to provide a unified and accurate intervention technique to all participants. Therefore, our findings were not considered to be heavily influenced by a selection or measurement bias.

5 | CONCLUSION

To the best of the authors' knowledge, this is the first study to comprehensively investigate the effects of a hand massage with a warm hand bath on sleep, autonomic nervous activity, and subjective relaxation. This intervention in the evening improved sleep efficiency and SL in elderly women with sleep disturbance. These findings suggest that a hand massage with a warm hand bath may improve subjective sleep quality and relaxation.

ACKNOWLEDGMENTS

We would like to offer special thanks to the participants in this study. We would also like to acknowledge Prof. (ret.) Katsuyuki Murata for help with the data analysis. This work was supported by JSPS KAKENHI Grant Number JP17K12073 from the Japan Society for the Promotion of Science.

DISCLOSURE OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

Y.K. conducted the study; M.S. contributed research ideas and aspects of the study design, made suggestions regarding the content of the manuscript, and provided advice during the entire study process; including Y.K. All authors contributed to the writing of the manuscript and approved the final version for submission.

ORCID

Yukiko Kudo https://orcid.org/0000-0001-9732-0323

REFERENCES

Buysse, D. J., Reynolds, C. F., III, Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*, 193–213.

Chen, M. L., Lin, L. C., Wu, S. C., & Lin, J. G. (1999). The effectiveness of acupressure in improving the quality of sleep of institutionalized residents. *The Journal of Gerontology. Series A, Biological and Medical Sciences*, *54*(8), 389–394.

Cole, R. J., Kripke, D. F., Gruen, W., Mullaney, D. J., & Gillin, J. C. (1992). Automatic sleep/wake identification from wrist activity. *Sleep*, *15*(5), 461–469.

Doi, Y., Minowa, M., Uchiyama, M., Okawa, M., Kim, K., Shibui, K., & Kamei, Y. (2000). Psychometric assessment of subjective sleep quality using the Japanese version of the

Pittsburgh Sleep Quality Index (PSQI-J) in psychiatric disordered and control subjects. *Psychiatry Research*, *97*, 165–172.

Eser, I., Khorshid, L., & Cinar, S. (2007). Sleep quality of older adults in nursing homes in Turkey: Enhancing the quality of sleep improves quality of life. *Journal of Gerontological Nursing*, *33*(10), 42–49.

Haimov, I., & Shatil, E. (2013). Cognitive training improves sleep quality and cognitive function among older adults with insomnia. *PLoS One*, *8*(4), e61390. https://doi.org/10.1371/journal.pone.0061390

Igusa, R., Aoki, K., Kameda, M., Iwasaki, K., Matsuda, T., & Masago, R. (2008). Assessment of autonomic nervous activity during and after foot massage for nursing care. *Journal of Japanese Society of Nursing Research*, *31*(5), 21–27 (in Japanese).

Imanishi, J., Watanabe, E., Watanabe, S., Sakurada, K., & Onouchi, Z. (2010). Improvement of sleep and cicadian rhythm disturbance in nursing home residents by aromatherapy massage: A preliminary study. *Japanese Journal of Complementary and Alternative Medicine*, *7*(2), 87–93. https://doi.org/10.1625/jcam.7.87

Janssen, P., Shroff, F., & Jaspar, P. (2012). Massage therapy and labor outcomes: A randomized controlled trial. *International Journal of Therapeutic Massage & Bodywork*, *5*(4), 15–20.

Japan Society of Neurovegetative Research. (2015). *Autonomic nervous system function tests* (5th ed., pp. 49–53). Tokyo, Japan: Bunkodo Co., Ltd (in Japanese).

Kales, A., & Kales, J. D. (1974). Sleep disorders. Recent findings in the diagnosis and treatment of disturbed sleep. *The New England Journal of Medicine*, *290*(9), 487–499. https://doi.org/10.1056/NEJM197402282900905

Khaledifar, A., Nasiri, M., Khaledifar, B., Khaledifar, A., & Mokhtari, A. (2017). The effect of reflexotherapy and massage therapy on vital signs and stress before coronary angiography: An open-label clinical trial. *ARYA Atherosclerosis*, *13*(2), 50–55.

Kim, K., Uchiyama, M., Okawa, M., Liu, X., & Ogihara, R. (2000). An epidemiological study of insomnia among the Japanese general population. *Sleep*, *23*(1), 41–47.

Koizumi, Y., Kohno, Y., Kyuji, K., Kimoto, M., Sakai, K., Sakai, K., … Kitamoto, F. (2012). Effects of tactile care by the content analysis of the practice record. *Journal of Japanese Society of Nursing Research*, *35*(4), 91–99 (in Japanese).

Kolcaba, K., Schirm, V., & Steiner, R. (2006). Effects of hand massage on comfort of nursing home residents. *Geriatric Nursing*, *27*(2), 85–91.

Kudo, Y., Sasaki, M., Kikuchi, Y., Sugiyama, R., Hasebe, M., & Ishii, N. (2019). Effect of a warm hand bath on blood flow in the shoulder, skin and deep body temperature, autonomic nervous activity and subjective comfort in healthy women: An experimental crossover trial. *Japan Journal of Nursing Science*, *16*, 88–100. https://doi.org/10.1111/jjns.12216

Kunikata, H., Watanabe, K., Miyoshi, M., & Tanioka, T. (2012). The effects measurement of hand massage by the autonomic activity and psychological indicators. *The Journal of Medical Investigation*, *59*(1–2), 206–212.

Lund, I., Lundeberg, T., Kurosawa, M., & Uvnäs-Moberg, K. (1999). Sensory stimulation (massage) reduces blood pressure in unanaesthetized rats. *Journal of the Autonomic Nervous System*, *78*(1), 30–37.

Mamun, K., & Lim, J. K. (2009). Association between falls and high-risk medication use in hospitalized Asian elderly patients. *Geriatrics & Gerontology International*, *9*(3), 276–281. https://doi.org/10.1111/j.1447-0594.2009.00533.x

McCullough, J. E. M., Liddle, S. D., Close, C., Sinclair, M., & Hughes, C. M. (2018). Reflexology: A randomised controlled trial investigating the effects on beta-endorphin, cortisol and pregnancy related stress. *Complementary Therapies in Clinical Practice*, *31*, 76–84. https://doi.org/10.1016/j.ctcp.2018.01.018

Mei, L., Miao, X., Chen, H., Huang, X., & Zheng, G. (2017). Effectiveness of Chinese hand massage on anxiety among patients awaiting coronary angiography: A randomized controlled trial. *The Journal of Cardiovascular Nursing*, *32*(2), 196–203. https://doi.org/10.1097/JCN.0000000000000309

Mobini-Bidgoli, M., Taghadosi, M., Gilasi, H., & Farokhian, A. (2017). The effect of hand reflexology on anxiety in patients undergoing coronary angiography: A single-blind randomized controlled trial. *Complementary Therapies in Clinical Practice*, *27*, 31–36. https://doi.org/10.1016/j.ctcp.2017.01.002

Nayak, U. B., Acharya, V., Jain, H., & Lenka, S. (2013). Clinical assessment of the autonomic nervous system in diabetes mellitus and its correlation with glycemic control. *Indian Journal of Medical Sciences*, *67*(1–2), 13–22. https://doi.org/10.4103/0019-5359.120691

Nedate, K., & Agari, I. (1984). Effects of cognition of physiological state and actual physiological responses upon emotion. *Japanese Journal of Behavior Therapy*, *9*(2), 33–39 (in Japanese).

Ohayon, M. M., Carskadon, M. A., Guilleminault, C., & Vitiello, M. V. (2004). Meta-analysis of quantitative sleep parameters from childhood to old age in healthy individuals: Developing normative sleep values across the human lifespan. *Sleep*, *27*(7), 1255–1273.

Paul, L., & Vaschillo, E. (2003). Heart rate variability biofeedback: A new tool for improving autonomic homeostasis and treating emotional and psychosomatic diseases. *Japanese Journal of Biofeedback Research*, *30*, 7–16.

Reichmuth, K. J., Austin, D., Skatrud, J. B., & Young, T. (2005). Association of sleep apnea and type II diabetes: A population-based study. *American Journal of Respiratory and Critical Care Medicine*, *172*(12), 1590–1595.

Sato, T. (2006). Effects of hand massage on the human autonomic nervous system and mood in healthy women. *Yamanashi Nursing Journal*, *4*(2), 25–32.

Seyyedrasooli, A., Valizadeh, L., Zamanzadeh, V., Nasiri, K., & Kalantri, H. (2013). The effect of footbath on sleep quality of the elderly: A blinded randomized clinical trial. *Journal of Caring Sciences*, *2*(4), 305–311. https://doi.org/10.5681/jcs.2013.036

Shinkoda, H., Park, Y. M., & Matsumoto, K. (1998). A basic study on the use of a wrist actigraph for identifying human various activities and sleep/wakefulness. *The Journal of Science of Labour*, *74*(7), 255–265 (in Japanese).

Takahashi, M. (1996). *The effect of relaxation on guided imagery of pregnant women and fetuses*. Grant-in-Aid for Scientific Research (General Research C) Result Report (Grant No. 06807183), 1–83 (in Japanese).

Tan, X., Uchiyama, M., Shibui, K., Tagaya, H., Suzuki, H., Kamei, Y., … Takahashi, K. (2003). Circadian rhythms in humans' delta sleep electroencephalogram. *Neuroscience Letters*, *344*(3), 205–208.

Tanaka, H., Taira, K., Uezu, E., Kamei, Y., Nakajima, T., Arakawa, M., … Shirakawa, S. (2000). The examination of sleep-health and life habits of elderly persons in long-life prefecture Okinawa and megalopolitan Tokyo from the viewpoint of area differences. *Japanese Journal of Geriatric Psychiatry*, *11* (4), 425–433 (In Japanese).

Task Force of the European Society of Cardiology the North American Society of Pacing Electrophysiology. (1996). Heart rate variability: Standards of measurement, physiological interpretation, and clinical use. *European Heart Journal*, *17*(3), 354–381. https://doi.org/10.2345/journal.cs.0012345

Teofilo, L., Cynthia, M., & Rita, B. (2009). *Fundamentals of sleep technology* (2nd ed., pp. 15–27). Philadelphia, PA: Lippincott Williams & Wilkins.

Uchiyama, M., Okawa, M., Shibui, K., Kim, K., Tagaya, H., Kudo, Y., … Takahashi, K. (2000). Altered phase relation between sleep timing and core body temperature rhythm in delayed sleep phase syndrome and non-24-hour sleep-wake syndrome in humans. *Neuroscience Letters*, *294*(2), 101–104.

Yamamoto, Y., Tanaka, H., Takase, M., & Shirakawa, S. (1999). Standardization of revised version of OSA sleep inventory for middle age and aged. *Brain Science and Mental Disorders*, *10*, 401–409 (in Japanese).

How to cite this article: Kudo Y, Sasaki M. Effect of a hand massage with a warm hand bath on sleep and relaxation in elderly women with disturbance of sleep: A crossover trial. *Jpn J Nurs Sci*. 2020;17: e12327. https://doi.org/10.1111/jjns.12327