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"Improving Sleep Quality with a Cosmetic Self-Facial Massage using a Neuroscientific Approach"

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1. Introduction

Sleep disturbance is one of the most important concerns in public health [1], affecting an estimated 15 to 20% adults worldwide. This concern has recently been exacerbated by both the physical impact of COVID-19 and the associated psychological distress experienced by healthcare workers and the general population. [2] Accumulated sleep debt due to chronic sleep deprivation or sleep disorders is associated with factors such as long working/commuting hours, trend toward the nuclear family/single marital status, smoking, alcohol consumption, physical discomfort in pathological cases, obesity, stress, depression, and anxiety. [1,3–5]

Sleep deprivation significantly affects mood. Studies have shown that the impact of insufficient sleep is more pronounced on mood than on cognitive or motor dysfunctions. [6-8] Generally, poor sleep quality is correlated with increased reactivity to negative emotional stimuli (measured by changes in pupil size), a high level of negative emotions, and a low level of positive emotions. Sleep deprivation also affects facial skin, which has social implications and can influence perceptions of attractiveness. Individuals with sleep deprivation are perceived as less healthy and less attractive,[10] appear sadder,[11] and may be deemed less desirable for social interactions.[12]

In addition to medical or pharmacological solutions, several nonpharmacological interventions have been proposed to promote sleep. One effective method for addressing sleep issues is sleep hygiene education, which involves instructing how to optimize sleep schedule and pre-bed routine, to harness habits to make quality sleep feel more automatic, and to create a pleasant bedroom environment.[7] While most reviews report positive effects of such interventions on sleep quality, the effects are generally modest, with substantial methodological variation.[13] Techniques known to reduce stress and arousal, such as relaxation, massage, aromatherapy, and mind-body exercises, have also been evaluated for their potential to improve sleep.[7,13]

Studies on massage therapy for various clinical conditions show consistent effects, such as reductions in anxiety, depression, and stress.[14] Recent comprehensive reviews report several studies showing positive effects of massage on sleep across various populations, with or without aromatherapy; however, a few studies have not shown significant effects.[13] The impact of a bedtime massage routine has been demonstrated in infants, improving sleep markers in both mothers and infants after two weeks.[15] Higher massage frequency was associated with better sleep outcomes, and the application of lotion as part of the massage enhanced the beneficial effects on sleep patterns.[16] and more recently, a study suggest that a daily facial massage may improve the perceived sleep quality and well-being. [9]

Based on these insights, we examined effects of the facial skin care at bedtime with a combination of self-massage and a pleasantly scented beauty serum on sleep in women aged 20 to 69. The sleep improvement effects of relaxation massage combined with the use of a cosmetic beauty serum for six consecutive dayswere evaluated in an exploratory basis.

2. Materials and Methods

This study was conducted from October 2023 to December 2023, with 60 participants initially divided into three groups based on the timing of their menstrual cycles, so that each participant underwent measuring EEG and answering the questionnaires in hypothermic/follicular phase.

Objective and subjective sleep quality were measured during two phases. An 1st measurement period (T1) to have a baseline, and an 2nd measurement period (T2) to evaluate the impact of the intervention. Thanks to sleep scores collected with EEG and questionnaires during T1, participants were randomly assigned and divided into two groups for the T2: a control group (30 participants; 50.9±9.4 yrs) and a pre-bed routine group (30 participants; 50.9±10.0 yrs). Each phase lasted 5 nights and avoided menstruation period. Sleep questionnaires were performed before going to sleep and post sleep, and EEG measure was performed during 5 nights.

During the T2, the control group kept their usual lifestyle. The pre-bed routine group implemented the intervention using the test product (the serum) with a specific gesture of self-massage daily for 6 days, 30 minutes before bedtime, while maintained their usual lifestyle with the same control and restrictions.

This analysis evaluated the interaction effect between periods (T1 vs. T2) and groups (pre-bed routine vs. control), as well as the main effects.

2.1 EEG

Sleep was assessed via a wearable electroencephalography (EEG) device (InSomnograf; S'UIMIN Inc., Tokyo, Japan), which is lightweight (162 g) and easy to wear due to its soft disposable adhesive electrodes (5 g). These electrodes were placed in three locations: the forehead and mastoids (behind earlobe), as shown in Figure 1. The device measures 2 Ch. EEG, 1 Ch. EOG and 1 Ch. EMG, and sleep scoring of these data according to AASM Scoring Manual Version 3 shows an 86.9% concordance rate and a kappa coefficient of 0.80 when compared with sleep scoring of the data obtained by simultaneous measurement of the polysomnography.[17] From the result of the sleep scoring, i.e., hypnogram, various sleep parameters including total sleep time, sleep efficiency, sleep onset latency, wake time after sleep onset (WASO), percentage of non-REM sleep stage 3, are calculated. Delta power (Figure 2), a key parameter reflecting the power density of the deep sleep (non-REM sleep stage 3), was also analyzed in this study.

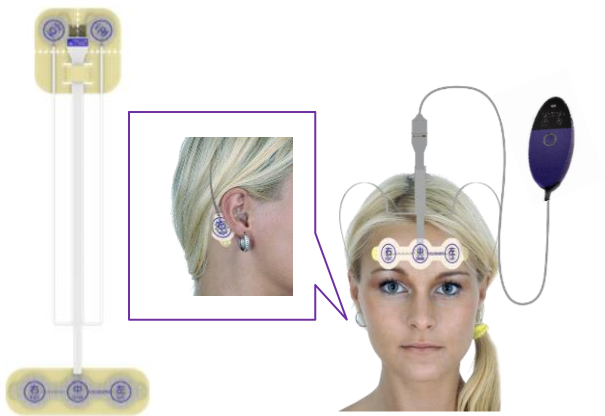


Figure 1. Electroencephalography device and its disposable electrodes.

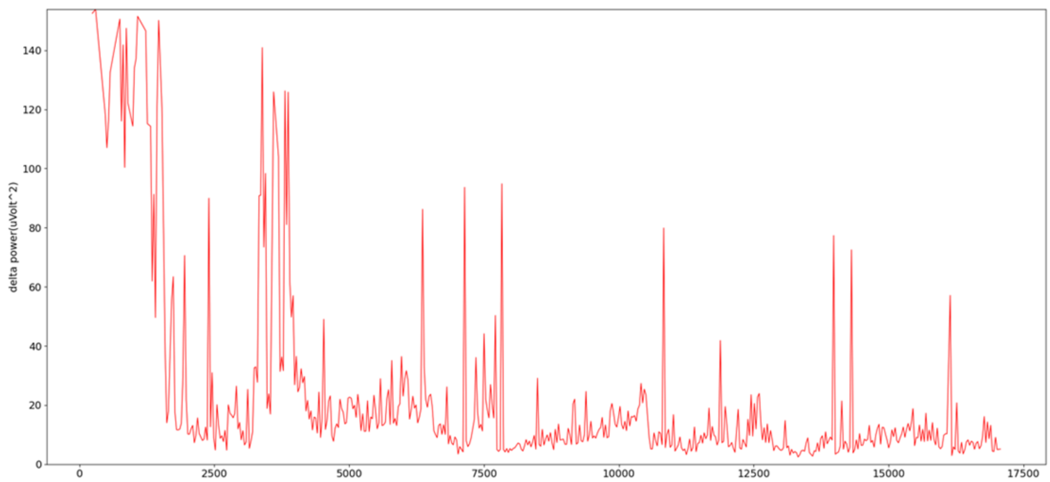


Figure 2．Example of Delta Power Spectrum Analysis in Sleep EEG

2.2 Questionnaires

Others sleep measures was also conducted thanks questionnaires.

The Epworth Sleepiness Scale (ESS) was used to assess daytime sleepiness. [19] The Athens Insomnia Scale (AIS) was used to measure the severity of insomnia. [20] The Morning

Questionnaire, also referred to as the Ogri-Shirakawa-Azumi sleep inventory MA version (OSA-MA), is designed to evaluate subjective sleep quality and recovery upon waking. [21] The levels of anxiety was also measured with State-Trait Anxiety Inventory (STAI, [22]) just before the baseline (T1).

3. Results

Participant characteristics were similar between the groups. They had a mean age of 50.9 ± 9.4 years for the pre-bed routine group and 50.9 ± 10 years for the control group. At baseline, all participants had excessive daytime sleepiness (EES > 10) with a mean EES score of 11.1 ± 4.5 for the pre-bed routine group and 13 ± 3.9 for the control group.

	Intervention Group		F	Control Group		F	Time	Group	Interaction	F
Variables	T1	T2		T1	T2		p	p	p	
n	30			30						
Age (years)	50.9±9.4			50.9±10.0						
Athenes Insomnia Scale (score)	8.3±3.9	5.6±3.1*	25.75	8.1±3.2	7.0±3.7	3.68	<0.001	0.454	0.030	4.98
Epworth Sleepiness Scale (score)	11.1±4.5	9.3±4.2*†	9.74	13.0±3.9	11.8±4.1	3.95	<0.001	0.031	0.426	0.64
OSA-MA										
Sleepiness on rising (score)	39.3±7.4	42.6±7.6*	12.97	39.9±7.5	40.8±7.9	0.98	0.002	0.732	0.070	3.41
Initiation and maintenance of sleep (score)	39.2±5.9	42.1±6.4*	9.66	41.5±5.3	43.8±6.5*	6.42	<0.001	0.162	0.687	0.16
Frequent dreaming (score)	48.4±8.8	51.3±7.6*	4.20	48.2±8.5	49.6±8.1	0.98	0.036	0.620	0.457	0.56
Refreshing (score)	39.7±7.5	43.5±5.7*	13.85	40.5±7.1	40.8±6.5	0.05	0.007	0.550	0.016	6.10
Sleep length (score)	38.7±7.0	40.3±6.9	2.31	39.9±5.9	39.6±5.9	0.10	0.399	0.887	0.200	1.68
Total score (score)	205.4±23.3	219.7±23.2*	20.81	209.9±24.4	214.5±24.2	2.11	<0.001	0.958	0.032	4.83
EEG										
Sleep latency (min)	16.3±17.5	20.1±15.4	2.15	18.0±14.8	20.0±14.3	0.58	0.120	0.825	0.622	0.25
REM latency (min)	65.4±22.6	64.5±23.7	0.06	69.3±40.7	67.9±40.0	0.13	0.671	0.654	0.938	0.01
N1 (min)	13.3±5.4	14.2±7.4	0.72	15.8±9.3	14.4±6.7	1.90	0.708	0.457	0.121	2.47
N1 occurrence rate (%)	3.7±1.3	3.9±1.7	0.58	4.6±2.6	4.1±1.8	3.66	0.419	0.257	0.064	3.57
N2 (min)	196.4±42.0	194.3±47.7	0.25	187.9±36.6	192.0±43.3	0.48	0.892	0.625	0.402	0.71
N2 occurrence rate (%)	54.4±8.9	53.9±9.7	0.23	53.9±8.2	53.9±8.7	0.00	0.750	0.912	0.723	0.13
N3 (min)	51.6±26.7	50.1±27.1	0.40	54.9±28.6	56.1±28.7	0.25	0.926	0.508	0.429	0.63
N3 occurrence rate (%)	14.7±7.9	14.7±8.7	0.00	15.5±7.3	15.7±7.6	0.09	0.838	0.652	0.821	0.05
REM (min)	95.5±27.7	94.0±27.3	0.27	89.6±23.4	90.5±22.9	0.12	0.902	0.457	0.544	0.37
REM occurrence rate (%)	26.2±6.2	26.6±7.4	0.32	25.2±5.2	25.5±5.4	0.13	0.513	0.488	0.887	0.02
Total sleep time (min)	360.7±48.3	355.2±47.3	0.54	351.2±55.3	356.0±48.5	0.42	0.951	0.716	0.334	0.95
Wake After Sleep Onset (min)	34.9±17.8	30.8±18.2	3.01	32.0±20.0	33.6±23.0	0.44	0.452	0.992	0.095	2.88
Sleep efficiency (%)	87.8±4.7	87.6±4.9	0.07	87.5±6.2	86.9±6.1	0.54	0.486	0.716	0.734	0.12
Number of sleep stage transitions (time)	36.2±11.5	36.6±11.9	0.07	37.5±13.0	36.8±10.5	0.25	0.864	0.800	0.597	0.28
Delta power										
Sum of peaks' integrals (uVolt^2 * sec)	404644±142621	404365±156311	0.00	416548±194943	435790±193084	1.02	0.484	0.620	0.471	0.53
Maximum peak value (uVolt^2)	95.0±38.7	102.4±42.6	0.56	108.0±64.6	114.4±72.1	0.43	0.326	0.344	0.946	0.01

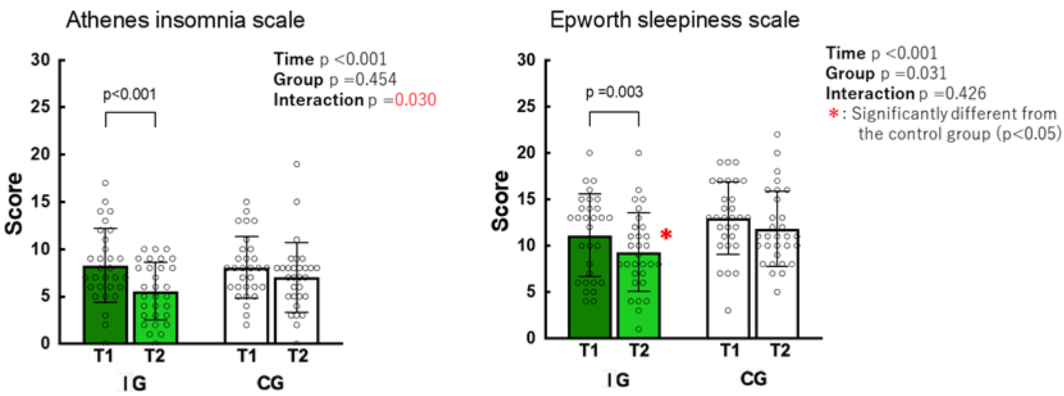
* Different from T1 ($p < 0.05$); † Different from the Control group ($p < 0.05$).

All p-values were obtained using two-way repeated-measures ANOVA. Results were presented as mean ± SD.

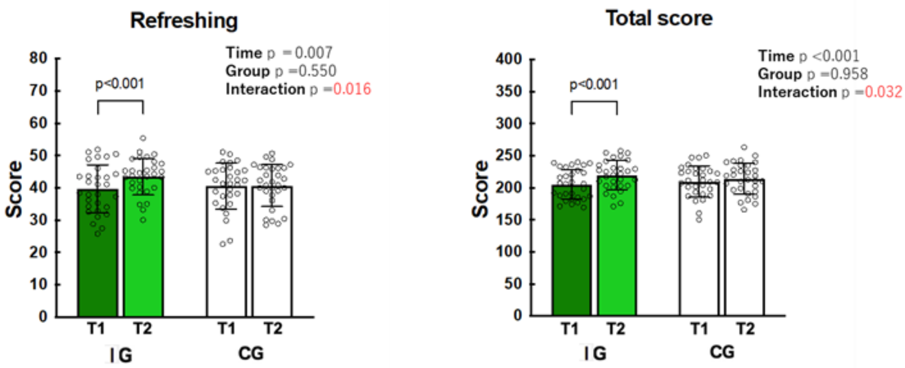
EEG: Electroencephalography; REM: Rapid Eye Movement sleep; N1: Non-REM Stage 1; N2: Non-REM Stage 2; N3: Non-REM Stage 3

Table 1: Results of Subjectives and Objectives measures of sleep

The pre-bed routine group (IG) showed improved sleep quality, with significant reductions in AIS (from 8.3 to 5.6; $p < 0.001$) and ESS scores (from 11.1 to 9.3; $p = 0.003$) compared to baseline (T1). Additionally, this group experienced improvements in OSA-MA scores of morning sleepiness, dreaming, sleep onset and maintenance, and fatigue recovery. Notably, a significant interaction effect for the OSA-MA total scores (p =0.032) was found with a significant increase only in the pre-bed routine group compared to the baseline ($p < 0.01$). Moreover, a significant interaction effect for fatigue recovery (p =0.0016) indicated significant improvements in the pre-bed routine group, with no changes in the control group.

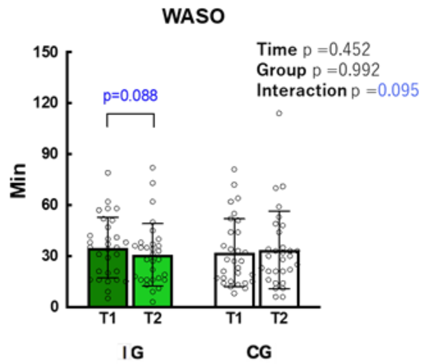


Graph 1 : Athens Insomnia Scale (AIS) and Epworth Sleepiness Scale (ESS)

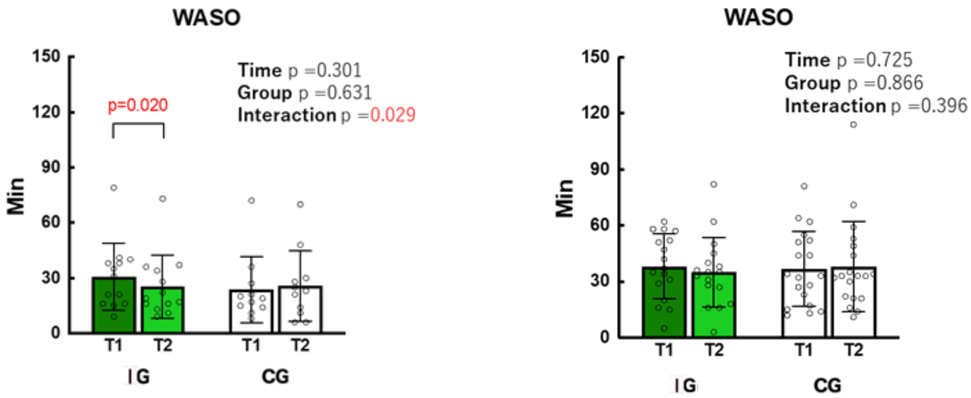


Graph 2 : OSA Sleep Inventory（OSA-MA)

WASO (wake after sleep onset) showed a trend of interaction effect to decrease in the pre-bed routine group after the skincare compared to baseline (p = 0.088). Moreover, in stratified analysis by age, a greater decrease in WASO was observed in participants aged 50 years or younger (p = 0.029), suggesting a more pronounced effect of the skincare with the test product in this age group. In addition to the age-stratified analysis, a stratified analysis based on anxiety levels was also conducted. In the high-anxiety group, the pre-bed routine group showed a significantly shorter WASO at T2 compared to T1, while no significant change was observed in the control group (Interaction p value = 0.006, Time p value for the pre-bed routine group = 0.004). The other measures showed no significant changes between the pre-bed routine and control groups.

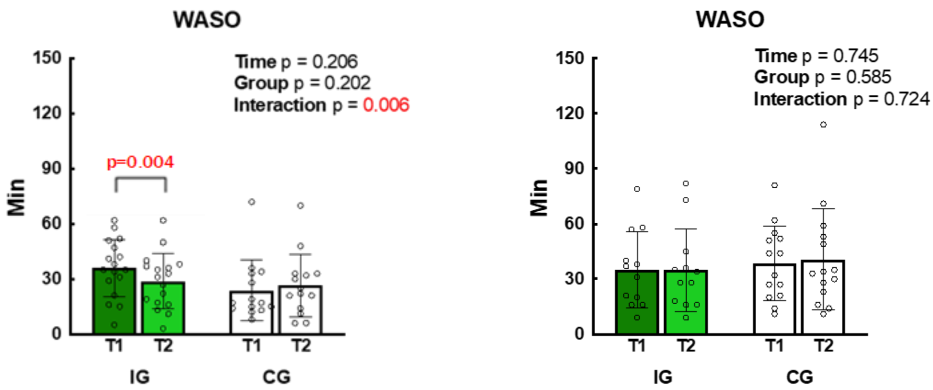


Graph 3 : Mean of Wake After Sleep Onset (WASO, N = 60)



(a) (b)

Graph 4 : Mean of Wake After Sleep Onset (WASO) : (a) : Participants Aged 50 Years and Younger (b) : Participants Aged 51 Years and Older



(a) (b)

Graph 5 : Mean of Wake After Sleep Onset (WASO) for (a) : Participants with High Anxiety Levels ; (b) : Participants with Low Anxiety Levels

We also analyzed delta power to assess its potential in evaluating sleep improvement of the intervention. Both the maximum peak values and the sum of the peaks' integrals, however, were found to show no significant differences between the pre-bed routine and control groups.

4. Discussion

The results of this study suggest that skincare tested product alongside the specific gesture of self-massage have a significant beneficial effect on sleep quality and reduce risks of sleep disorders. Specifically, the intervention group demonstrated a notable reduction in AIS and ESS scores when they applied the skincare routine, indicating reduced insomnia symptoms and daytime-sleepiness. The results suggest that self-massage and the components of tested product can have a positive influence on sleep quality. Furthermore, the higher scores in the sleepiness on rising and the fatigue recovery on the OSA-MA suggest that the skincare routine may not only improve sleep quality but also enhance refreshing effects of sleep. This implies that the effects of the skincare routine go beyond skin benefits, potentially contributing to enhanced daytime performance through improved sleep quality—an especially valuable feature for individuals with stressful lifestyles.

In terms of EEG results, the tendency for a decrease in WASO by the intervention was notable, especially among participants aged 50 years or younger. This subgroup analysis suggests that the effects of the skincare using the test product may be more pronounced in younger populations, potentially influenced by age-related changes in skin and sleep structures. Additionally, when stratified by anxiety levels, the analysis revealed that participants with higher anxiety levels in the intervention group experienced a significant reduction in WASO at T2 compared to T1, whereas no significant change was observed in the control group. This finding indicates that individuals with elevated anxiety may respond more effectively to the intervention, as anxiety is known to impact sleep quality, particularly by increasing wakefulness after sleep onset. [18] Further studies are needed to elucidate the underlying mechanisms in greater detail.

5. Conclusion

In conclusion, this study's findings suggest that the skincare routine using the newly developed cosmetic product positively impacts sleep quality. Specific improvements were observed in reductions in insomnia symptoms and daytime sleepiness, wakefulness and refreshment upon awakening, and a trend toward shorter wake times after sleep onset, suggesting beneficial effects on both sleep and daytime alertness. These results suggest that the skincare routine with the cosmetic product could contribute to improvements in sleep quality and overall quality of life.

6. References

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