

# Subjective and objective assessment of sleep behaviors of Japanese mothers and their 5- to 7-month-old infants

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# Subjective and objective assessment of sleep behaviors of Japanese mothers and their 5- to 7-month-old infants

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## Abstract

**Purpose:** The purpose of this study was to assess the sleep behaviors of Japanese mothers subjectively and objectively and their 5- to 7-month-old infants.

**Methods:** The participants were 36 pairs of mothers and their 5- to 7-month-old infants. Each mother and infant were regarded as a pair and their sleep behavior was observed. Sleep behavior was assessed subjectively and objectively. The subjective data was collected using the self-administered Pittsburgh Sleep Quality Index Japan (PSQI-J) and Kwansai Gakuin Sleepiness Scale (KSS) questionnaires, and the objective data was collected using a Lifecorder GS (Suzuken Co., Ltd., Nagoya, Japan) accelerometer. Lifecorder GS data were collected over the same period for both mothers and infants.

**Results:** The mothers' subjective PSQI-J sleep assessment score averaged  $6.00 \pm 2.58$  and their average sleep efficiency was  $84.57 \pm 11.96\%$ . The Lifecorder GS objectively measured the mothers' average sleep efficiency at  $75.21 \pm 8.29\%$  and the number of periods of awakening spanning 10 minutes or more as  $3.64 \pm 1.56$  periods. Subjective and objective sleep efficiency data were significantly different ( $p < 0.01$ ). The average sleep efficiency for infants, as measured by the Lifecorder GS, was  $66.70 \pm 9.59\%$ , and their average number of periods of awakening spanning 10 minutes or more was  $6.34 \pm 1.61$  times. The correlation coefficient for mother and infant sleep duration was 0.44 ( $p < 0.01$ ). There were two types of awakening during sleep; one in which the mother's awakening preceded the infant's, and the other in which the infant's awakening preceded the mother's. It was confirmed that sleep and awakening could be bidirectional between the mother and the infant.

**Conclusions:** There was a significant difference in the subjective and objective sleep efficiency data for mothers who had 5- to 7-month-old infants. The mothers did not feel that their sleep efficiency had been adversely affected due to sleep interruption to care for their infants, however, objectively it was confirmed that sleep efficiency was lowered. The researchers think there is a need to develop education to improve sleep quality for Japanese mothers and their infants while carefully maintaining the child-raising culture.

## KEY WORDS

Mother, Infant, Sleep, Behavior, Assessment

## Introduction

According to data released by the Organization for Economic Cooperation and Development in 2014<sup>1)</sup>, Japanese people get little sleep, and women in Japan get the least amount of sleep in the world. Remarkably, Japanese women sleep less than the men, which is

uncommon internationally<sup>1, 2)</sup>. A sleep study using smart phones<sup>3)</sup> also showed comparable results. Japan has many sleep-related problems, as the country's infants and young children also get the least amount of sleep in the world<sup>1, 4)</sup>.

In Japan, "yonaki" (night crying, i.e., infants cry at

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night without sleeping) has been considered a great problem. Night crying occurs in 60% of all children in Japan<sup>5, 6)</sup>. This has long been considered a part of a child's developmental process, however, in recent years, the view has shifted to considering it as a part of Japan's child-rearing culture and customs<sup>7)</sup>. Japan has a unique child-rearing culture that involves practices such as the mother and child sharing a room or bed. Mothers are often unable to sleep when their children cry at night, causing sleep-related problems for them during the nursing period.

Previous studies on the sleeping behavior of infants show that 47.7% of mothers responded that night crying began when infants were aged 5-7 months<sup>8)</sup> and the crying hit its peak at 5-8 months, which led to a detrimental lack of sleep experienced by parents<sup>9)</sup>. The infant's wake-up time was most strongly influenced by the wake-up time of the mother<sup>10)</sup>, according to the mothers' responses on the questionnaires in these subjective studies. A few studies have been conducted on healthy infants based on objective data collected using videotape recorders<sup>11)</sup> or acceleration sensors<sup>12)</sup>, however, the actual state of nighttime sleep of mothers with 5- to 8-month-old infants has not been clarified.

Girschik et al.<sup>13)</sup> conducted a sleep study using actigraphy with 56 women aged 18 to 80 years in Western Australia. They found that participants whose subjectively collected data showed that they got less than 6 hours of sleep per night had underestimated their sleep duration when compared with the objective data. Further, those who got more than 8 hours of sleep a night tended to overestimate their sleep duration. The study revealed that sleeping behavior cannot be accurately identified using subjectively collected data alone. There has been no research on a mother's sleeping behavior during the child's toddler stage that uses both subjective and objective data. Moreover, most studies have focused either on the infants and young children or on the mothers; few studies have simultaneously examined both mothers and children<sup>2, 14)</sup>.

The sleeping habits of infants and young children may be influenced by co-sleeping<sup>15-17)</sup>, signifying the need for a sleep evaluation that targets both the mother and child simultaneously.

The purpose of this study was to subjectively and

objectively assess the sleep behaviors of Japanese mothers and their 5- to 7-month-old infants, and the sleep challenges mothers face.

## Participants

The participants were recruited at local government maternal and child health centers in "Chubu" prefectures A and B. The participants consisted of 36 mothers who consented to participate in this study and their 5- to 7-month-old infants.

## Methods

### 1. Variables and Instruments

#### 1) Demographics

The questionnaire comprised questions about the ages of the mother and infant, birth order, employment status and working arrangements if employed, family structure, the mother's sleep behaviors before pregnancy, and a subjective assessment of the mother's health.

#### 2) Sleep behaviors

##### (1) Subjective Data

The Kwansai Gakuin Sleepiness Scale (KSS)<sup>18)</sup> is a self-reported Japanese questionnaire based on the Stanford Sleepiness Scale<sup>19)</sup> and is used as a subjective measure of an individual's level of wakefulness and drowsiness. This questionnaire consists of 22 items such as heavy eyelids and lightheadedness. The average score for each item shows the level of sleepiness. A high score indicates higher sleepiness. The reliability and validity of KSS have been confirmed<sup>18)</sup>.

PSQI-J is the Japanese version of the Pittsburgh Sleep Quality Index<sup>20)</sup>, and its reliability and validity have been confirmed<sup>21)</sup>. This questionnaire consists of 18 items regarding sleep quality, including 4 items about sleep habits and 10 items about sleep-related problems and the reasons that made sleeping difficult (e.g. waking up during the night). The scores range from 0 to 21, with the cut-off point above 6. A high score indicates poor sleep quality. The sleep efficiency is calculated from the question items of PSQI-J as actual sleep time / time in bed × 100. Sleep efficiency is categorized from good to bad as "85% or more," "75% to 85%," "65% to 75%," and "less than 65%".

##### (2) Objective Data

A Lifecorder GS (Suzuken Co., Ltd., Nagoya, Japan)

accelerometer was used to measure the sleeping behavior of the mothers and infants. It was fastened to the mother's waist during the day and across her torso at night (over her clothes), and to the torso of the infant (over its clothes) during both day and night. For evaluating sleep using Lifecorder GS, nighttime sleep and behavior were analyzed using dedicated software (Sleep Sign Act), and its reliability and validity have been confirmed<sup>22)</sup>. The results are expressed in both actograms and values. By integrating the sleep variable values and the amount of activity, it is possible to graph sleep patterns and activity. Actograms indicate sleep as blue, white for less than 10 minutes of wakefulness, and yellow for more than 10 minutes of wakefulness.

## 2. Data Collection and Submission

Consenting mothers were given the KSS and PSQI-J questionnaires and the Lifecorder GS. The KSS was completed upon waking for 7 days and the PSQI-J was completed on the 7th day. The Lifecorder GS was worn by each mother and infant and their sleep was measured for 7 days. The mother put the Lifecorder GS on the infant. The KSS, PSQI-J, and Lifecorder GS surveys were conducted during the same period. At the end, participants returned the questionnaires and the Lifecorder GS to the researcher by mail. When the results of the Lifecorder GS were returned to the mothers at the local government health centers, the researcher reviewed reasons for sleep difficulty reported in the PSQI-J in more detail.

## 3. Study period

Data were collected between October and December of 2014 and 2015. To ensure an adequate number of participants, the survey was conducted at the same time of year over a two-year period. The same time period was chosen to exclude the effect of seasonal variation on sleep data.

## 4. Analyses

For KSS and PSQI-J, the normality distributions of the data were checked and the mean and standard deviation were calculated.

KSS, PSQI-J, and Lifecorder GS data were classified into two groups according to PSQI-J (subjective data) scores; greater than or equal to 6 points, and less than 6 points. These two groups were compared using the Mann-Whitney U Test. Similarly, sleep efficiency as measured by the Lifecorder GS (objective data) was

classified into two groups; 75% or more (high efficiency group) and less than 75% (low efficiency group), and the group variables were analyzed using the Mann-Whitney U Test.

Differences between subjective (PSQI-J) and objective (Lifecorder GS) assessments of mothers' sleep efficiency and sleep duration were analyzed using the Wilcoxon signed-rank test. The relationship between the mother's and infant's sleep patterns was analyzed using Pearson's correlation coefficient and Spearman's rank correlation coefficient. Statistical significance was set at  $p < 0.05$ .

## 5. Ethical considerations

This study was conducted after obtaining approval from the Kanazawa University Medical Ethics Committee (approval 541-1, 629-1). Prior to the start of the study, a written and oral overview of the study was provided to the administrator of local government health centers, and written consent was obtained for research at the centers. Participants were individually briefed verbally and in writing at the centers on the purpose and methods of the research and on ethical considerations. Participants' consent for the study was obtained in writing. Participants were assured that they could not be identified, they could withdraw their consent at any time, they would not be disadvantaged by non-participation, and that the results of the sleep assessment would be returned to them after the study.

## Results

### 1. Participants' characteristics

The participants comprised 36 mothers and their infants (each mother had one infant). Participants' characteristics are shown in Table 1.

The mothers' mean age was  $32.7 \pm 4.4$  years, and 33 (91.7%) were in nuclear families. None of the mothers were working during the study period. They slept well before their pregnancies. As for the breakdown of sleep behaviors, 24 slept well, 29 did not have any problems related to being awakened at night, 30 did not wake up too early in the morning, and 20 did not experience drowsiness during the day. The infants were all aged 5-7 months, and 26 (72.2%) were firstborn.

2. Comparison of subjective and objective assessment of sleep behavior according to PSQI-J scores indicating possible sleep disorders

Table 1: Participants' characteristics

Variable		N=36 n (%)
Mother		
Age (years) mean ± SD		32.7 ± 4.4
Employment status	unemployed	23 (63.9)
	on parental leave	13 (36.1)
Family structure	nuclear family	33 (91.7)
Sleep behavior before pregnancy		
sleep well	yes	24 (66.7)
	no	12 (33.3)
wake up during night	yes	7 (19.4)
	no	29 (80.6)
wake up too early	yes	6 (16.7)
	no	30 (83.3)
daytime sleepiness	yes	16 (44.4)
	no	20 (55.6)
feel healthy	yes	35 (97.2)
	no	1 (2.8)
Infant		
Birth order	firstborn	26 (72.2)

SD: Standard deviation

Table 2 shows a comparison of results for KSS, PSQI-J and Lifecorder GS according to the cut-off point for PSQI-J.

Average scores for KSS and PSQI-J were 3.50 ± 0.84 and 6.00 ± 2.58 respectively, and average sleep efficiency according to the PSQI-J was 84.57 ± 11.96%.

The sleep efficiency of the mothers as measured by the Lifecorder GS was 75.21 ± 8.29% and the mean time woken up at night was 10.36 ± 3.59 minutes. The sleep efficiency of the infants was 66.70 ± 9.59% and the mean time awake at night was 13.42 ± 3.15 minutes.

Comparison of PSQI-J scores by the two groups showed that the KSS mean of those scoring 6 or more on the PSQI-J was significantly higher than those scoring less than 6 (p<0.05). PSQI-J sleep efficiency was 90.19 ± 10.16% for those scoring less than 6 and significantly higher than those scoring 6 or more at 81.01 ± 12.30% (p<0.05). For the mothers' Lifecorder GS, there was no significant difference in sleep efficiency or the number of times they woke up at night between those with a PSQI-J score of 6 or more and those with a score of less than 6.

Related to the PSQI-J score shown in Table 2, 32 mothers chose the item "Other" as the reason for difficulty sleeping. Upon further questioning, it was confirmed that the mothers were unable to sleep due to the necessity to care for their infants during the night.

Table 2: Comparison of subjective and objective assessment of sleep behavior according to PSQI-J scores indicating possible sleep disorders

Item	Variable	PSQI-J			p-value
		Total N = 36 mean ± SD	under 6 n = 12 mean ± SD	6 or more n = 24 mean ± SD	
KSS	KSS average	3.50 ± 0.84	3.06 ± 0.73	3.72 ± 0.82	0.025
	KSS average minimum value	2.39 ± 0.94	1.95 ± 0.85	2.61 ± 0.92	0.044
	KSS average maximum value	4.63 ± 0.86	4.36 ± 1.01	4.77 ± 0.77	0.191
PSQI-J	Score average	6.00 ± 2.58	3.33 ± 1.44	7.38 ± 1.86	0.000
	Sleep efficiency (%)	84.57 ± 11.96	90.19 ± 10.16	81.01 ± 12.30	0.032
	Bedtime (hh:mm)	22:40 ± 1:09	22:16 ± 0:47	22:54 ± 1:16	0.099
	Wake-up time (hh:mm)	6:43 ± 0:54	6:32 ± 0:52	6:45 ± 0:59	0.452
	Sleep duration (hr:min)	7:59 ± 1:23	8:16 ± 1:14	7:50 ± 1:28	0.387
	Sleep efficiency (%)	75.21 ± 8.29	74.16 ± 7.68	75.73 ± 8.70	0.598
Lifecorder GS	Mother				
	Average length of time awake (min:sec)	10:36 ± 3:59	9:50 ± 2:55	10:55 ± 3:53	0.395
	Number of times awakened	9.28 ± 3.83	11.03 ± 3.70	8.40 ± 3.65	0.051
	Number of times awakened for longer than 10 minutes	3.64 ± 1.56	3.88 ± 1.48	3.52 ± 1.62	0.523
	Sleep efficiency (%)	66.70 ± 9.59	72.56 ± 8.23	63.78 ± 8.99	0.008
Infant	Sleep duration (hr:min)	6:18 ± 1:08	6:51 ± 1:06	6:02 ± 1:04	0.041
	Average length of time awake (min:sec)	13:42 ± 3:15	12:20 ± 3:36	14:26 ± 2:53	0.067
	Number of times awakened	13.25 ± 2.65	11.98 ± 2.74	13.89 ± 2.24	0.039
	Number of times awakened for longer than 10 minutes	6.34 ± 1.61	5.31 ± 1.57	6.86 ± 1.39	0.005

Mann-whitney U test, SD: Standard deviation, KSS:Kwansei Gakuin Sleepiness Scale, PSQI-J: Pittsburgh Sleep Quality Index Japan  
 Length of time expressed as hr:min:sec i.e. hours:minutes:seconds  
 Actual time expressed using 24-hour clock; hh:mm, hh (00 to 23):mm (00 to 59)

In the infant's Lifecorder GS, the sleep efficiency of those with PSQI-J less than 6 points was  $72.56 \pm 8.23\%$ , significantly higher than the  $63.78 \pm 8.99\%$  of those with 6 or more points ( $p < 0.01$ ). For PSQI-J scores less than 6, the average number of times infants woke up was  $11.98 \pm 2.74$  times, significantly less than the  $13.89 \pm 2.24$  times for those scoring more than 6 ( $p < 0.05$ ).

### 3. Comparison of subjective and objective assessment of sleep behavior according to Lifecorder GS sleep efficiency

Table 3 shows a comparison of results for KSS, PSQI-J and Lifecorder GS according to sleep efficiency as measured by the Lifecorder GS.

We divided the Lifecorder GS sleep efficiency of the mothers into two groups of over 75% (high efficiency group) and under 75% (low efficiency group) and then compared the groups (Table 3). No difference was observed in the scores of these groups on the KSS. There was no significant difference between the "high efficiency group" and the "low efficiency group" in the PSQI-J.

The sleep efficiency of mothers in the "low efficiency group", according to Lifecorder GS data, was  $69.30 \pm 4.45\%$ , which was significantly lower than that of mothers in the "high efficiency group" at  $82.59 \pm 5.55\%$  ( $p < 0.001$ ). Lifecorder GS data showed that mothers in the "low efficiency group" woke up  $11.52 \pm 3.05$  times at night and  $4.55 \pm 1.19$  times for 10 minutes or more at night, which was significantly higher than the "high efficiency group" who woke up  $6.48 \pm 2.71$  times ( $p < 0.001$ ) and  $2.50 \pm 1.18$  times for 10 minutes or more at night ( $p < 0.001$ ).

There was no significant difference in the infants' Lifecorder GS results.

### 4. Sleep efficiency and duration as assessed by the PSQI-J and the Lifecorder GS

Sleep efficiency and sleep duration were compared for the PSQI-J, the mother's subjective data, and the objective data of Lifecorder GS (Table 4). Sleep efficiency was  $84.57 \pm 11.96\%$  for PSQI-J, which was significantly higher than that of the Lifecorder GS at  $75.21 \pm 8.29\%$  ( $p < 0.01$ ).

In terms of average sleep duration, PSQI-J was 7 hr

Table 3: Comparison of subjective and objective assessment of sleep behavior according to Lifecorder GS sleep efficiency

Item	Variable	Lifecorder GS sleep efficiency			p-value
		Total N = 36 mean $\pm$ SD	under 75% n = 20 mean $\pm$ SD	75% or more n = 16 mean $\pm$ SD	
KSS	KSS average	3.50 $\pm$ 0.84	3.58 $\pm$ 0.84	3.40 $\pm$ 0.87	0.533
	KSS average minimum value	2.39 $\pm$ 0.94	2.42 $\pm$ 0.99	2.36 $\pm$ 0.91	0.840
	KSS average maximum value	4.63 $\pm$ 0.86	4.72 $\pm$ 0.8	4.52 $\pm$ 0.95	0.478
PSQI-J	Score average	6.00 $\pm$ 2.58	5.95 $\pm$ 2.37	6.13 $\pm$ 2.89	0.843
	Sleep efficiency (%)	84.57 $\pm$ 11.96	83.99 $\pm$ 12.28	85.29 $\pm$ 11.9	0.752
	Bedtime (hh:mm)	22:40 $\pm$ 1:09	22:34 $\pm$ 1:13	23:49 $\pm$ 1:08	0.530
	Wake-up time (hh:mm)	6:43 $\pm$ 0:54	6:48 $\pm$ 1:08	6:32 $\pm$ 0:37	0.407
	Sleep duration (hr:min)	7:59 $\pm$ 1:23	8:10 $\pm$ 1:09	7:38 $\pm$ 1:26	0.258
	Sleep efficiency (%)	75.21 $\pm$ 8.29	69.30 $\pm$ 4.45	82.59 $\pm$ 5.55	0.000
	Sleep duration (hr:min)	5:51 $\pm$ 0:55	5:39 $\pm$ 0:56	6:07 $\pm$ 0:50	0.125
Lifecorder GS	Mother Average length of time awake (min:sec)	10:36 $\pm$ 3:59	11:19 $\pm$ 3:07	9:12 $\pm$ 3:28	0.066
	Number of times awakened	9.28 $\pm$ 3.83	11.52 $\pm$ 3.05	6.48 $\pm$ 2.71	0.000
	Number of times awakened for longer than 10 minutes	3.64 $\pm$ 1.56	4.55 $\pm$ 1.19	2.50 $\pm$ 1.18	0.000
	Sleep efficiency (%)	66.70 $\pm$ 9.59	64.54 $\pm$ 8.47	69.41 $\pm$ 10.47	0.132
	Sleep duration (hr:min)	6:18 $\pm$ 1:08	6:02 $\pm$ 0:55	6:38 $\pm$ 1:18	0.115
Infant	Average length of time awake (min:sec)	13:42 $\pm$ 3:12	14:19 $\pm$ 3:14	13:00 $\pm$ 3:34	0.231
	Number of times awakened	13.25 $\pm$ 2.65	13.51 $\pm$ 2.55	12.94 $\pm$ 2.82	0.527
	Number of times awakened for longer than 10 minutes	6.34 $\pm$ 1.61	6.49 $\pm$ 1.57	6.16 $\pm$ 1.69	0.550

Mann-whitney U test, SD: Standard deviation, KSS:Kwansei Gakuin Sleepiness Scale, PSQI-J: Pittsburgh Sleep Quality Index Japan  
Length of time expressed as hr:min:sec i.e. hours:minutes:seconds  
Actual time expressed using 24-hour clock; hh:mm, hh (00 to 23):mm (00 to 59)

Table 4: Sleep efficiency and duration as assessed by the PSQI-J and Lifecorder GS

(N=36)			
Variable	PSQI-J	Lifecorder GS	p-value
Sleep efficiency (%)	84.57 ± 11.96	75.21 ± 8.29	0.002
Sleep duration (hr : min)	7:59 ± 1:23	5:51 ± 0:55	0.000

Wilcoxon signed-rank test, SD: Standard deviation, PSQI-J: Pittsburgh Sleep Quality Index Japan  
 Length of time expressed as hr:min:sec i.e. hours:minutes:seconds

Table 5: Mother and child's sleep behavior according to the Lifecorder GS

(N = 36)				
Variable	Mother	Infant	Correlation coefficient	p-value
	mean ± SD	mean ± SD		
Sleep efficiency <sup>a</sup> (%)	75.21 ± 8.29	66.70 ± 9.59	0.09	0.620
Sleep duration <sup>a</sup> (hr:min)	5:51 ± 0:55	6:18 ± 1:08	0.44	0.007
Average length of time awake <sup>a</sup> (min:sec)	10:36 ± 3:59	13:42 ± 3:15	0.33	0.046
Number of times awakened <sup>b</sup>	9.28 ± 3.83	13.25 ± 2.65	0.06	0.718
Number of times awakened for longer than 10 minutes <sup>b</sup>	3.64 ± 1.56	6.34 ± 1.61	-0.20	0.248

<sup>a</sup> Pearson correlation coefficient, <sup>b</sup> Spearman's rank correlation coefficient, SD: Standard deviation  
 Length of time expressed as hr:min:sec i.e. hours:minutes:seconds

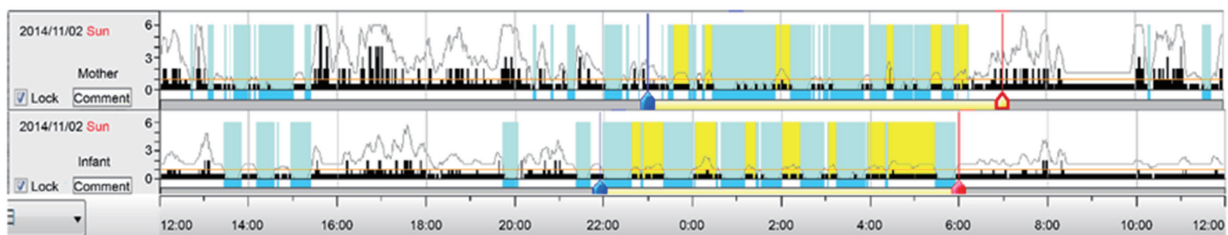


Fig.1 Actogram illustrating the mother's and infant's sleep behavior where the mother awoke first (No. T20143). The top graph shows the mother's sleep behavior, and the bottom graph shows the infant's. In the actogram, the vertical axis is activity, the horizontal axis is time, and 0:00 is midnight. Blue indicates sleep, white indicates less than 10 minutes of wakefulness, and yellow indicates more than 10 minutes of wakefulness. The blue flag indicates bedtime and the red flag indicates wake-up time. The mother fell asleep at about 23:00 and the infant fell asleep at about 22:00. By the time the infant woke up at 6:00, it had awakened 8 times for 10 minutes or more and 4 times for less than 10 minutes. The mother had awakened 6 times for 10 minutes or more and awakened 10 times or more for less than 10 minutes.

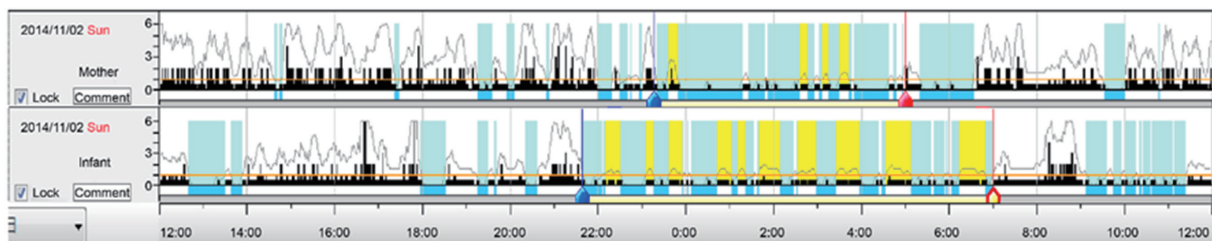


Fig.2 Actogram illustrating the mother's and infant's sleep behavior where the infant awoke first (No. M20141). The top graph shows the mother's sleep behavior, and the bottom graph shows the infant's. In the actogram, the vertical axis is activity, the horizontal axis is time, and 0:00 in the center is midnight. Blue indicates sleep, white indicates less than 10 minutes of wakefulness, and yellow indicates more than 10 minutes of wakefulness. The blue flag indicates bedtime and the red flag indicates wake-up time. The mother fell asleep at about 23:20, and the infant fell asleep at about 21:30. The mother had four awakenings of 10 minutes or more and four awakenings of less than 10 minutes. The mother awakened slightly after the infant did. By the time the infant woke up at 7:00, it had awakened for 10 minutes or more 10 times and awakened for less than 10 minutes 10 times.

59 min  $\pm$  1 hr 23 min, approximately two hours more than the 5 hr 51 min  $\pm$  0 hr 55 min of the Lifecorder GS, which was significantly different ( $p < 0.001$ ).

5. Comparison of the mothers' and infants' sleep status using the Lifecorder GS

We compared the mothers' and infants' sleep behaviors in terms of their Lifecorder GS data (Table 5). A significant correlation was found for mothers' and infants' sleep duration with a correlation coefficient of 0.44 ( $p < 0.01$ ) and also for the average length of time awake with a correlation coefficient of 0.33 ( $p < 0.05$ ).

Figures 1 and 2 show the actograms of two pairs of mothers and infants measured over a 24-hour period. According to Figure 1, the mother fell asleep at about 23:00 and the infant fell asleep at about 22:00. By the time the mother woke up at 7:00, she had awakened 6 times for 10 minutes or more and awakened 10 times or more for less than 10 minutes. The infant woke up at 6:00 and had awakened 8 times for 10 minutes or more and 4 times for less than 10 minutes.

We observed different patterns in the actograms in which the infant's awakening preceded the mother's and the mother's awakening preceded the infant's, as well as cases where the mother did not wake up when her infant awoke and the infant went back to sleep by itself.

For example, in Fig 1 the mother awoke a little before 2:00 and the infant woke a little after that. Fig 2 shows that the infant woke at around 2:30 and the mother woke up slightly after. In contrast, in Fig 2 the infant was observed to wake up at 1:00 but the mother did not awake.

## Discussion

### 1. Participants' characteristics

This study focused on mothers raising an infant aged between 5 and 7 months. Infants in this age group represent the majority of cases where their mothers are not working, are in a nuclear family situation and covers the age of 6 months when infants' night crying typically peaks<sup>8)</sup>.

The mothers in this study were mostly full-time homemakers or on parental leave, and most of them lived in nuclear families. Approximately 75% of the families in the child care period in Japan are nuclear families, and over 70% of those who continue working take childcare leave until their child is at least 8

months old<sup>23)</sup>. Hence, Japanese mothers of 5- to 7-month-old infants are rarely working. We considered the participants of this study to have the same characteristics as those of previous studies.

### 2. Mother and infant sleep behaviors

In this study, the mother and her infant were examined as one pair, and their sleep was measured by fastening a Lifecorder GS to both. Collected objective data showed that the sleep efficiency of the mothers was 75.21%, and the average number of times they awoke for more than 10 minutes was 3.64, resulting in a situation where the mother had poor sleep quality. The sleep efficiency of the infants was also lower than that of the mothers, at 66.70%.

Previous studies have demonstrated infants' sleeping behavior using questionnaire data as filled in by the mothers<sup>2, 10, 14, 15)</sup>. Other studies have used objectively collected data targeting a select few cases where the infants were experiencing some form of sleep-related problem, such as night crying<sup>24)</sup>.

In a study, mothers who complained that their 6- to 14-month-olds infants had a problem of night crying had their infants' sleep measured by fastening actigraphs to them. The infants' sleep efficiency rate was adequate, at around 90%, and they woke for more than 5 minutes 5 times per night on average. Nakagawa and Sukigara<sup>12)</sup> also assessed infants' sleeping behavior by fastening actigraphs. The average sleep efficiency rate of the infants at 6 months was 89.0%, and they were awake for more than 5 minutes, 4.2 times per night on average. However, these previous findings were inconsistent in terms of the research conditions, such as the infants' age and the fact that the seasons when the studies took place were not reported. To minimize season-related influences, this study was conducted during months when air conditioning and heating were not required at night. Even so, infants' sleep efficiency was 66.70% which is worse than previous studies found. Further study is required to explain these differences.

Mosko et al.<sup>25, 26)</sup> and Sadeh et al.<sup>27)</sup> reported that the number of times the mother and child woke up was significantly higher for those who shared a bed than those who slept in separate rooms. In Japan, the mother and her child often sleep in the same room or share a bed<sup>15, 17)</sup>; few mothers sleep separately. However, we did not compare the differences in these



two situations.

Eto<sup>11)</sup> used videotaping to study how 1-month-old infants' sleep was affected by co-sleeping with mothers. Consistently, the results confirmed that not only did the mothers' waking influence the infants' sleep, but infants' sleeping and waking behavior also affected the mother. Shinkoda<sup>14)</sup> reported that the infants' sleeping rhythm was influenced by their mothers' sleeping habits. In the present study, using the Lifecorder GS as an objective data tool to assess sleep, we confirmed that the mothers' awakening preceded the infants' and the infants' awakening also influenced the mothers.

3. Sleep behavior of mothers of 5- to 7-month-old infants

In this study, by investigating subjective and objective sleep data collected simultaneously, it became clear that mothers were not aware that their sleep was being interrupted to take care of their infants. 32 of the 36 mothers who participated in this study reported having "other" sleep disruptions on the PSQI-J. The actual frequency, degree, and reasons for sleep disruptions became known to these mothers once they had spoken to the researchers. Although the mothers had their sleep disrupted to care for their child, such cases were treated as time asleep, as they were not due to sleep disorders. Mothers' sleep status has previously been reported using subjective data<sup>7,8,10)</sup>, but the objectively measured values showed the mothers' actual sleep to be less than the subjective data.

Girschik et al.<sup>13)</sup> conducted a sleep survey using actigraphs and found that those who had a sleep duration of 6 hours or less based on subjective data underestimated the objective data and those who had a sleep duration of 8 hours or more overestimated the objective data. In contrast, in this study, the sleep time in all cases was shorter than the subjective data and sleep duration was overestimated. The reason behind the contrasting results is most likely due to the participants' age differences or diversity in lifestyle habits and child-rearing culture. Further, Sadeh et al.<sup>28)</sup> reported that 51.9% of the mothers surveyed (in the Asian region) perceived that their child had sleep problems; however, less than 20% of Japanese mothers reported the same. This could be because Japanese people have a high threshold when it comes to perceiving sleep problems.

Latz et al.<sup>17)</sup> posited that the Japanese custom of bed sharing with infants is not the cause of sleep disorders in children and that there is a need to consider cultural differences. In this study, by having both mother and infants wearing accelerometers, it was confirmed that the infants woke and went back to sleep by themselves, even if there was no behavior change by the mothers. We also found that as the infants fell asleep on their own, the mothers should not intervene more than is necessary. For both mothers and children to improve their sleep, mothers must improve their level of awareness and understand that they need not be overly vigilant about the children while they sleep. We hope that the quality and amount of sleep that the mothers of 5- to 7-month-old infants get will improve using the objective evidence from the study.

4. Limitations

This study had some limitations, such as the fact that the study was conducted in two regions with a small sample size. A larger sample size is needed confirm the findings.

5. Conclusion

This study clarified the current state of sleep of Japanese mothers and infants by simultaneously performing subjective and objective assessment of mothers' and infants' sleep behavior. There was a significant difference in subjective and objective sleep efficiency data for mothers who had 5- to 7- month-old infants. The mothers did not feel that their sleep efficiency had been adversely affected due to sleep interruption to care for their infants, however, objectively it was confirmed that sleep efficiency was lowered. The researchers think there is a need to develop education to improve sleep quality for Japanese mothers and their infants while maintaining child-rearing culture.

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## 母親とその5-7か月児の睡眠行動の主観的および客観的評価

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### 要 旨

目的：本研究の目的は、母親とその5-7か月児の睡眠行動を主観的および客観的に評価することである。

方法：本研究の対象は、母親とその5-7か月児36組である。母と児を一組と捉えて睡眠行動の評価を行った。睡眠行動は、主観的評価と同時に客観的評価を行った。主観的評価は、既存の自記式質問紙であるPittsburgh Sleep Quality Index Japan (PSQI-J)とKwansei Gakuin Sleepiness Scale (KSS)を使用し、客観的評価は、加速度計であるライフコーダーGSを用いて測定した。加速度計の測定は、母子ともに同一期間で実施した。

結果：母親の主観的睡眠の評価としてPSQI-Jでは平均点 $6.00 \pm 2.58$ 、睡眠効率の平均は $84.57 \pm 11.96\%$ であった。母親の客観的評価として、ライフコーダーGSの睡眠効率の平均は $75.21 \pm 8.29\%$ 、10分以上の覚醒は平均 $3.64 \pm 1.56$ 回であった。睡眠効率は、主観的評価と客観的評価の間に有意差があった( $p < 0.01$ )。児の客観的評価としてライフコーダーGSでは、睡眠効率の平均は $66.70 \pm 9.59\%$ 、10分以上の覚醒は平均 $6.34 \pm 1.61$ 回であった。母子の睡眠時間の間には、相関係数0.44で有意な相関( $p < 0.01$ )があった。睡眠中の覚醒には、母親の覚醒が先行するタイプと児の覚醒が先行するタイプの両タイプがあり、睡眠と覚醒は母子間で双方向性であった。

結論：5-7か月児の母親の主観的な睡眠効率のデータと客観的な睡眠効率のデータには有意な差があった。母親は育児のために睡眠を中断したことで睡眠効率に悪影響が出ているとは感じていなかったが、客観的には睡眠効率が低下していることが確認された。子育て文化を大事にしながら、日本の母親とその乳幼児の睡眠の質を向上させる教育を行う必要があると考えられた。