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Characteristics of Sleep Efficiency in Thai Children

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ABSTRCT

This study was descriptive research aimed to determine the characteristics of sleep pattern in Thai children (0 - 3 years old). Comparison of sleep efficiency in terms of sleep efficiency index (SEI), the time spent in each sleep stage (stage 1, 2, 3, 4 and rapid eye movement (REM) sleep), sleep latency (SL), and total sleep time (TST) between the night and day time were presented. In the comparison of the sleep efficiency between night and day time recordings of the participants, the mean percentage of the stage 1 NREM sleep during the night time was longer than during the day time with statistically significant difference between the two recording periods at level of .05. Stage 2 non-rapid eye movement (NREM) sleep during the night time was also longer than during the day time, but no statistically significant difference. The mean percentage of stage 3, 4 NREM and REM sleep during the night time were shorter than during the day time. There was no statistically significant difference between the two periods. The mean duration of SL during the night time (19.88±1.44 minutes) was longer than during the day time (21.29±2.06 minutes), but no statistically significant difference. The mean duration of TST during the night time (7.05±0.25) was longer than during the day time (0.91±0.10). In the same way, the mean duration of SL during the night time (9.72±0.18) was longer than during the day time (4.82±0.13). Also, the average SL during both periods of recording was longer than TST.

Keywords: Health promotion; Rapid eye movement (REM); Non-rapid eye movement (NREM); Sleep; Sleep pattern

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INTRODUCTION

Sleep is one of the basic needs of human beings and is very important for physical and mental health [1]. For children, each child, especially the newborn, has an individual sleep pattern with a different amount and length of sleeping time [2]. Newborn infants spend about two thirds of time sleeping in order to promote growth and development during the early phase of life [3] whereas term infants spend 16 to 18 hours sleeping each day [4]. The sleep pattern of newborn infants is a cycle which can be divided into 2 states; active sleep or rapid eye movement (REM) and quiet sleep or non rapid eye movement (NREM). Each cycle lasts from 50 to 60 minutes. Normally, the sleep pattern will begin with active sleep for about 10 to 45 minutes, followed by quiet sleep which lasts about 20 minutes [5]. Arousal of newborn infant appears after one or two sleep cycles [6]. Sleep in the newborn infant, especially quiet sleep, will enhance growth and restore basic tissue: this is necessary for recovery and rehabilitation of health [1]. In addition, quiet sleep produces the highest oxygenation level which may be beneficial for infants with respiratory problems. Active sleep is important for memory, learning and psychological adaptation and it has been hypothesized as being necessary for brain development [5].

The sleep pattern of newborn infants is controlled by the relative maturity of the central nervous system (CNS) [7]. Healthy newborn infants always demonstrate the sleep pattern as described above. Premature infants, who are born before the end of the last day of the 37^{th} week of gestation, still have an immature body system and CNS which affects their sleep patterns. Both the active and quiet sleep of premature infants are poorly organized and of short duration, as they easily respond to stimuli and move from quiet sleep to active sleep [8]. Also, premature infants are unprepared for life outside the uterine environment and demonstrate inappropriate adaptation which is linked to the immature function of neurophysiological development. They have an imbalance of all subsystems from the syndactive theory e.g., autonomic system, motor system, state organization system, attention/interactive and self-regulatory system. Especially, the state organization system involves the display of different ranges of sleeping and waking, and displays clarification of states where they are present [9]. This inappropriate adaptation results in most premature infants being admitted to a neonatal intensive care unit [10]. However, the extra-uterine environment of the hospital itself poses dangers to sleep. Environmental conditions which adversely affect sleep-wake patterns during hospitalization include poorly established light-dark differences, the continuous noise of monitors and staff conversation, exposure to activities and treatment protocols which mandate frequent interruption of sleep [1].

Considering all of the above, the researchers are interested in the factor affecting the sleep pattern of children. The results will be advantageous to the planning of nursing care to promote growth and development for children. The objective measurements of sleep efficiency include polysomnography (PSG). It is the continuous recording of electroencephalogram (EEG), electrooculogram (EOG), and electromyogram (EMG), respectively. The PSG is the only accurate measure of specific sleep cycle and its efficiency [11]. Sleep efficiency was measured by portable PSG in terms of sleep efficiency index (SEI), sleep stages, sleep latency (SL), and total sleep time (TST). To study the characteristic of sleep in normal children aged about 0-3 years using sleep I/T, these characteristics include sleep pattern, number of sleep cycle during night time and daytime, total sleep time during night time and daytime, percentage of REM sleep, and percentage of NREM sleep, respectively.

MATERIALS AND METHODS

Population

The target population of this study was both male and female Thai children who were lived central part of Thailand. Data collection was conducted in a two-month period during February to March 2006. Twenty-seven Thai children were selected by purposive sampling based on criteria as follows: (1) normal delivery, (2) normal birth weight (more than 2,500 grams, less than 4,000 grams), (3) have no head injury during delivery, (4) no seizure symptom, (5) must not a premature baby, (6) no illness before 7 days and during the experiment, (7) no history of sleep abnormality or disorder, (8) should sleep with his/her parents, and (9) parents were fully agreed and sign the agreement of the experiment.

Sample size

Sample size was based on the principle of Polit and Hungler [12], who suggested the sample of 20-30 cases. For comparison purpose, the number of samples in each group should not be less than 10 cases depending on the research design. This study used change-over design, in which all subjects served as their own control so they were in both the control and the intervention/investigation period. Moreover, limited sample size was due to high cost of the instrument used for data collection [12]. Therefore, the sample size for this study was 27 participants. Participants aged 0-3 years old.

Instrumentation

The instruments for data collection were consisted of (1) Portable polysomnography (PSG) was used to evaluate sleep efficiency in terms of the following aspects (a) Sleep efficiency index is the percentage of time spent asleep in any stage compared to the overall time in bed, (b) time duration spent in each sleep stage (stages1, 2, 3, and 4 NREM sleep, REM sleep) measured in minutes and as percentage of the total sleep time, (c) sleep latency is the time in minutes from the beginning of the PSG monitoring to onset of sleep, and (d) total sleep time is the number of hours spent on sleep per night, (2) instruments for data collection of the sleep-wake patterns in premature infants: video camera Panasonic Model. No. NY -Vx7EN, Video cassette (size 4x7.3 inches).

Polysomnographic Recording

Before each test, started sleep at p.m. the researcher and the research assistant placed EEG, EGG, EMG electrodes and wristband to the participants. Electrodes were placed on the specific area after skin preparation. After completing all the leads connections, the researcher set up the Sleep I/T device with the software on notebook computer followed the standard procedures. The Sleep I/T monitored sleep efficiency started sleep at p.m. and recorded throughout the night until the ended sleep at a.m. or before in the event the participants were awaken in the morning. During the recording session, the researcher stayed by the monitoring room to observe the participant's condition. Whereas the number of awakening and any interrupted events to the patient's sleep were recorded accordingly.

Data Analysis

The researcher observed the sleep patterns of children from videotape, coded in the observation record for duration and sleep-wake states. The researcher assessed the sleep-wake states of the children using the criteria: eyes open or closed respiratory pattern and body movement. The result of the sleep wave of each participant in each period had been read calculated in term of Percentage of sleep efficiency index, the time spent in each sleep stage (stages 1, 2, 3 and 4 NREM sleep), sleep latency and total sleep time. Data obtained was analyzed by using the Software Package of Social Statistic / Personal Computer (SPSS / PC) Version 11.5. Unpaired *t*-test was used to compare the difference in each sleep parameter between the night time and day time recordings.

RESULTS AND DISCUSSION

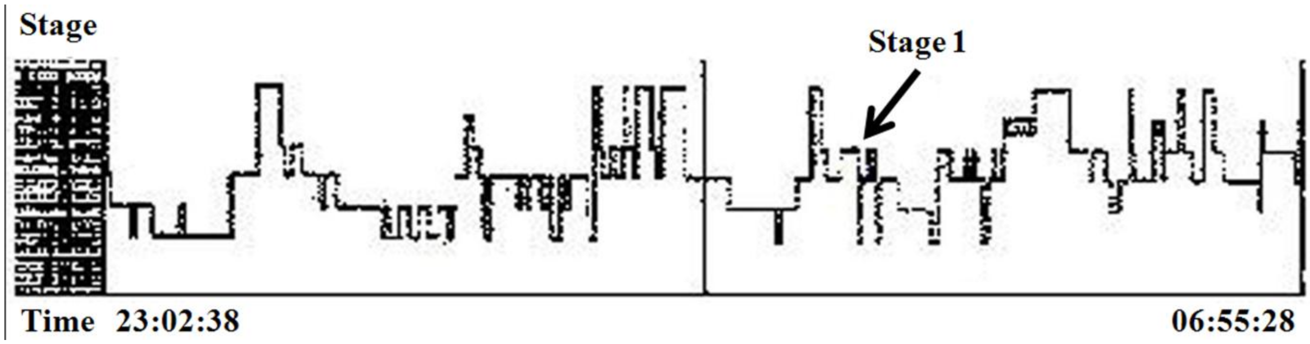
The sleep efficiency was objectively measured by Portable Polysomnography (PSG), which utilized the electroencephalography (EEG), the electromyelogram (EMG) and the electrooculogram (EOG) [11]. PSG represented SEI, time spent in each sleep stage (stages 1, 2, 3 and 4 NREM sleep, REM sleep), SL and TST while the participants slept during the night and day time. During the experimental period (e.g., night time recording), the mean SEI (79.98±1.48) was lower than the period during the day time (91.50±1.95). There was statistically significant difference of the mean SEI between the two periods of the study at level of 0.05 (see table 1).

Table 1: Comparison of the sleep efficiency between the night and day time recording of the participants (n = 27)

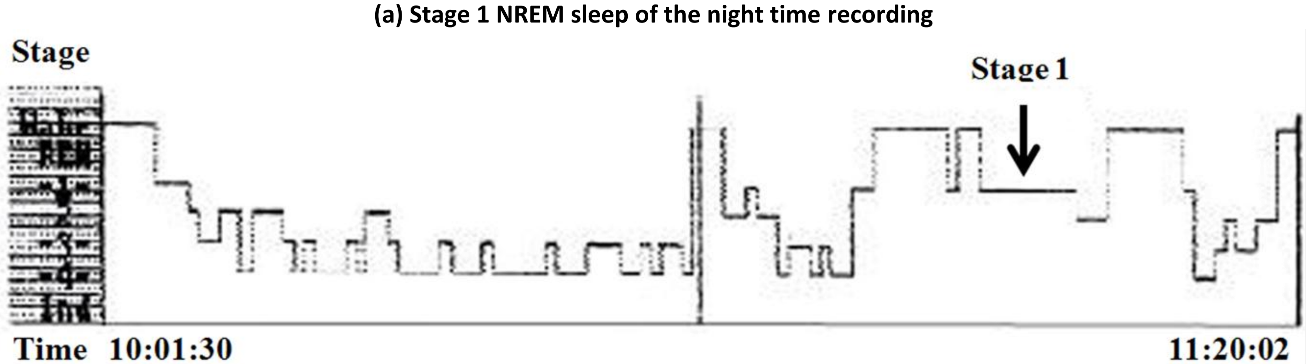
Sleep efficiency	Night time		Day time		t	p
	M	SEM	M	SEM		
Sleep Efficiency index (%)	79.98	1.48	91.50	1.05	6.34	<0.0001
Sleep Stages (%)						
Stage 1 NREM	19.34	2.94	16.29	1.04	0.98	<0.0001
Stage 2 NREM	41.38	2.52	36.28	1.78	1.67	0.11
Stage 3 NREM	12.12	1.14	14.42	1.36	1.30	0.21
Stage 4 NREM	13.06	1.31	17.88	2.17	1.90	0.07
Stage REM	14.09	0.90	14.64	1.07	0.39	0.70
Sleep Latency (minutes)	19.88	1.44	21.29	2.06	0.56	0.57
Sleep Log (hours) (n=27)	9.72	0.18	4.82	0.13	21.70	<0.0001
Sleep Log (hours) (n=135)	9.01	0.09	3.81	0.10	35.84	<0.0001
Total Sleep Time (hours)	7.05	0.25	0.91	0.12	2.88	<0.0001

REM = Rapid eye movement; NREM = Non-rapid eye movement; M = Mean; SEM = Standard Error of Mean

Time duration spent in each sleep stage was measured as the proportion of such stage compare to the TST. The mean percentage of stage 1 NREM sleep during the night time recording (19.34±2.94) was longer than during the day time recording (16.2±1.04). There was statistically significant difference of the mean percentage of stage 1 NREM sleep between the two periods of the study at level of .05 (see Figure 1).



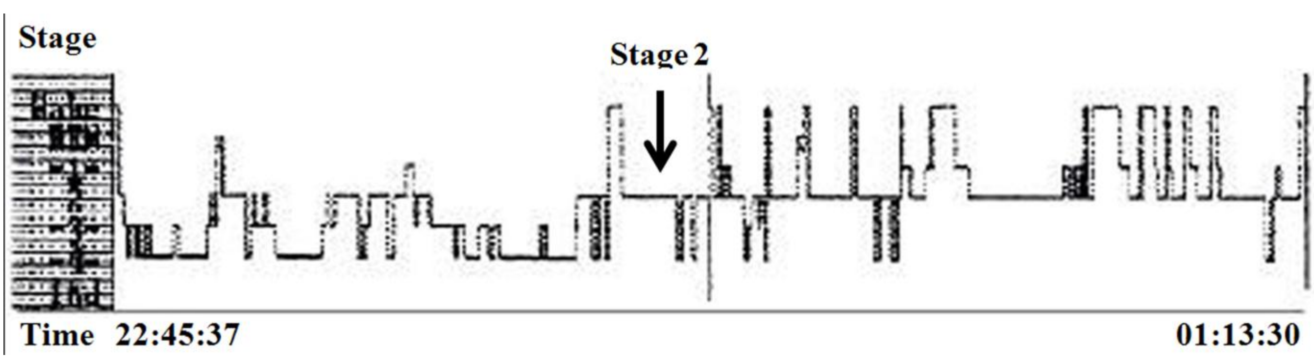
(a) Stage 1 NREM sleep of the night time recording



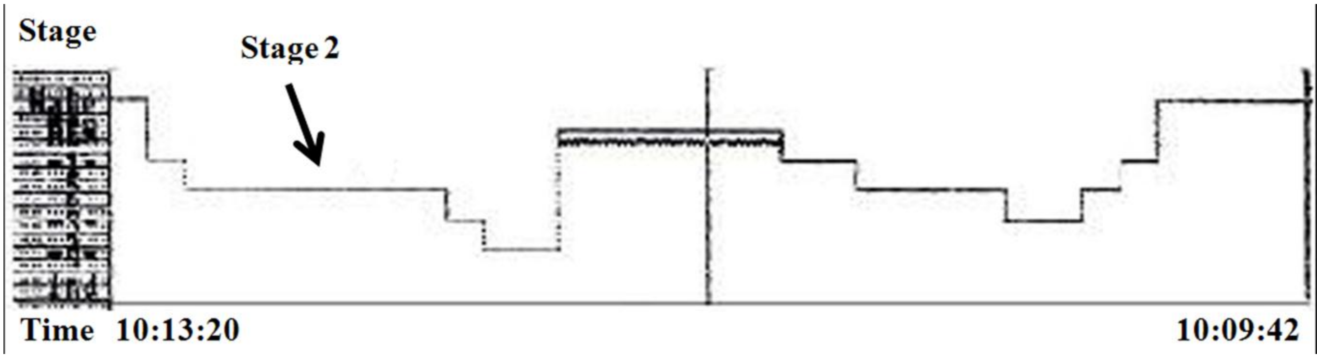
(b) Stage 1 NREM sleep of the day time recording

Figure 1 (a,b): Comparison of the stage 1 NREM sleep of the participants with 0-3 years during the night time and day time recordings.

The mean percentage of stage 2 NREM sleep during the night time recording (41.38±2.52) was longer than during the day time recording (36.282±1.78). There was no statistically significant difference (see Figure 2).



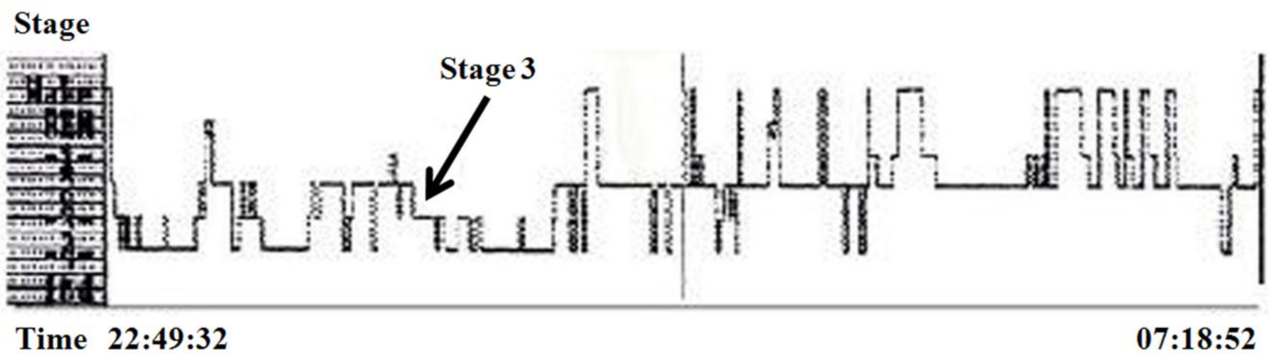
(a) Stage 2 NREM sleep of the night time recording



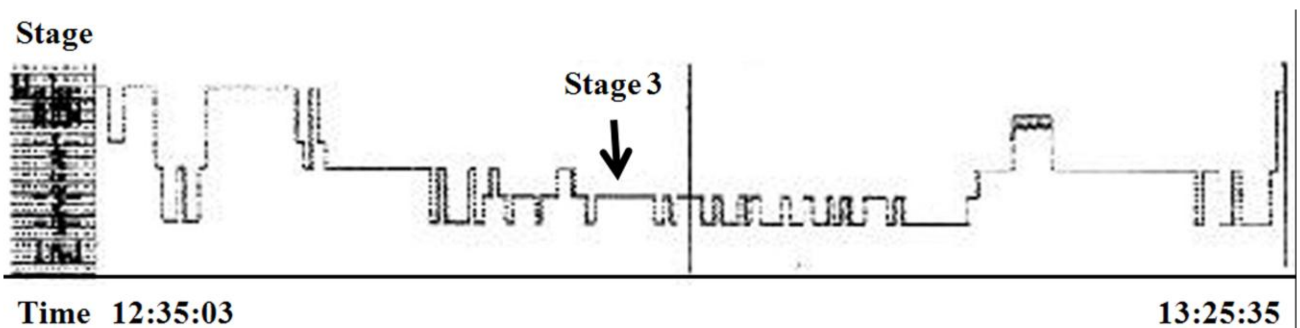
(b) Stage 2 NREM sleep of the day time recording

Figure 2 (a,b): Comparison of the stage 2 NREM sleep of the participants between 0-3 years old group during the night and day time recordings

Stage 3 NREM sleep during the night time recording (12.12±1.14) was shorter than during the day time recording (14.42±1.36). There was no statistically significant difference (see Figure 3).



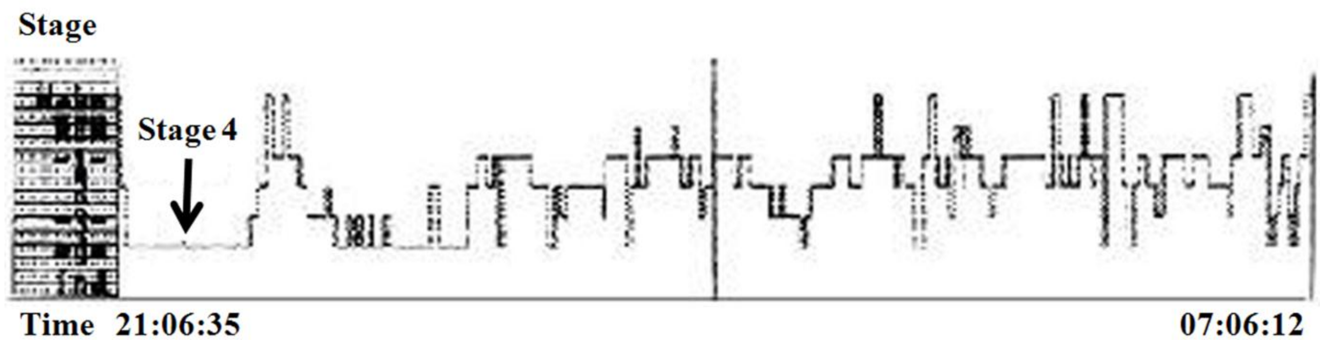
(a) Stage 3 NREM sleep of the night time recording



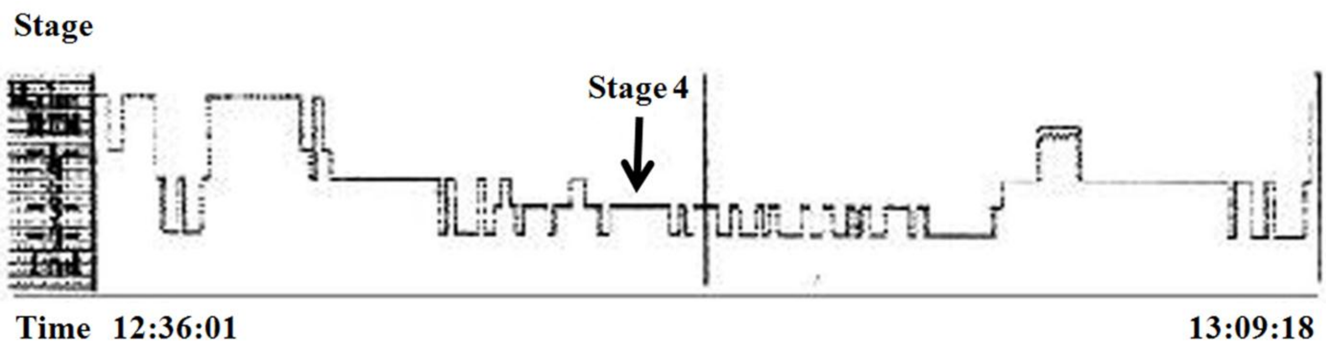
(b) Stage 3 NREM sleep of the day time recording

Figure 3 (a,b): Comparison of the stage 3 NREM sleep of the participants with 0-3 years old during the night time and day time recordings.

Stage 4 NREM sleep during the night time recording (13.06±1.31) was shorter than during the day time recording (17.88±2.17) (see Figure 4). There was no statistically significant difference. In the same way, the mean percentage of stage REM sleep during the night time recording (14.09±0.90) was equal to during the day time (14.64±1.07). There was no statistically significant difference.



(a) Stage 4 NREM sleep of the night time recording



(b) Stage 4 NREM sleep of the day time recording

Figure 4 (a,b): Comparison of the stage 4 NREM sleep of the participants with 0-3 years old during the night time and day time recordings

Therefore, the mean percentage of stage 1 NREM sleep during the night time was longer than during the day time with statistically significant difference between the two recording periods at level of .05. Stage 2 NREM sleep during the night time was also longer than during the day time, but no statistically significant difference. The mean percentage of stage 3, 4 NREM and REM sleep during the night time were shorter than during the day time. There was no statistically significant difference between the two periods.

The mean duration of SL during the night time recording (19.88±1.44 minutes) was longer than during the day time (21.29±2.06 minutes), but no statistically significant difference. The mean duration of TST during the night time (7.05±0.25) was longer than during the day time (0.91±0.10). There was statistically significant difference at level of .05. In the same way, the mean duration of SL during the night time (9.72±0.18) was longer than during the day time recording (4.82±0.13). There was statistically significant difference at level of .05. The average SL during both periods of recording was longer than TST.

From this study, it was found that the overall sleep efficiency of the participants was good. The average percentage of the SEI of the participants in both periods of the recording was higher than 80%, which reflected good sleep efficiency [1, 3, 6, 7]. During the experimental period, during the night time, the mean SEI (79.98±1.48) was lower than the period during the day time

(91.50±1.95). There was statistically significant difference of the mean SEI between the two periods of the study at level of .05. Time duration spent in each sleep stage was measured as the proportion of such stage compare to the TST. The mean percentage of stage 1 NREM sleep during the night time (19.34±2.94) was longer than during the day time (16.2±1.04). There was statistically significant difference of the mean percentage of stage 1 NREM sleep between the two periods of the study at level of .05.

CONCLUSION

The overall sleep efficiency of the participants was good. In the comparison of the sleep efficiency between the night and day time recording of the participants, the mean percentage of stage 1 NREM sleep during the night time was longer than during the day time with statistically significant difference between the two recording periods at level of .05. The mean duration of TST during the night time was longer than during the day time. There was statistically significant difference at level of .05. In the same way, the mean duration of SL during the night time was longer than during the day time. There was statistically significant difference at level of .05. The average SL during both periods of recording was longer than TST.

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