

## Disappearance process of diurnal naps of infants until 3 years after birth.

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### Abstract

The study aimed at describing the developmental change of diurnal naps during 2 to 46 months of age, with the data of sleep diary recorded by nursery teachers at a nursery school. Diurnal naps in the morning almost disappeared at 12 months after birth and completely disappeared by 18 months, while daytime nap in the afternoon peaked quantitatively at 18 months and then gradually decreased. The pattern of decrease of afternoon naps consisted from disappearance of nap outside of the narrower time zone (13:00 to 15:00) and concentration of nap in this time zone.

**Key words:** Developmental process, Diurnal naps, Infants, Toddlers

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Most organisms have a biological rhythm with a cycle of about 24 hours (circadian rhythm), which is close to the rotation period of the Earth. Sleep and wakefulness rhythm is also controlled by this circadian rhythm. However, newborn infants show no or scarce evidence of circadian variations in their sleep or waking states. The typical newborn sleeps approximately 16-17 hours per day, with periods of sleep and wakefulness evenly distributed between day and night (Parmelee and Stern, 1964). Developmental change of the sleep and wakefulness rhythm during early infancy is summarized into the process of transformation from the polyphasic pattern, which denotes that the short periods of sleep distribute evenly through 24 h, to the adult-like nocturnal sleep pattern. However, the timing when the circadian pattern of sleep emerges was unclear. Fukuda and Ishihara (1997) analyzed the sleep pattern of 10 full-term infants during about 6 months after their birth with the method of autocorrelation and cluster analysis and found the circadian rhythm of sleep and wakefulness emerged around the 7th week after birth. Takaya et al. (2009) showed the timing of emergence of the circadian rhythm depends on conception but not on the birth timing. Summarizing these results, the timing of the 7th week after birth should be interpreted as the timing of the 46th week after conception.

During 6 months after birth, sleep became consolidated and concentrated into night period of

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day, leaving some sleep during daytime, i.e., diurnal naps. Diurnal naps are known to decrease gradually during preschool period (Fukuda & Sakashita, 2002; Fukuda & Asaoka, 2004), however, the details of the disappearance pattern of the diurnal naps are not well described. The study aimed at describing the developmental change of diurnal naps during 2 to 46 months of age, with the data of sleep diary recorded by nursery teachers at a nursery school.

## Methods

**Participants:** We analyzed the records of daytime sleep of 47 infants aged 2 to 46 months (24 boys and 23 girls) at a public nursery school in Tokyo. The data was recorded in the diary by the nursery teachers.

**Procedures of Analysis:** The 24-hour time zone was divided into 10-minute intervals, and the epochs were coded as “one” when the infants were sleeping, as “zero” when they were awake. Based on the data, the proportion of the infants who were in a sleeping state at each epoch was calculated for each age, and the value indicates the sleep tendency at each time zone for each age. The target age was 2 to 46 months (3 years and 10 months). We also categorized the data by time zone in the morning and the afternoon to see the progress of daytime sleep by time zone. The data for the morning is from 9:00 to 12:00, and for the afternoon daytime sleep, the sleep propensity was calculated for rather broader time zone (12:00 to 16:00), and was again calculated for narrower time zone (13:00 to 15:00). The rates were calculated separately and the pattern of changes in daytime sleep was investigated.

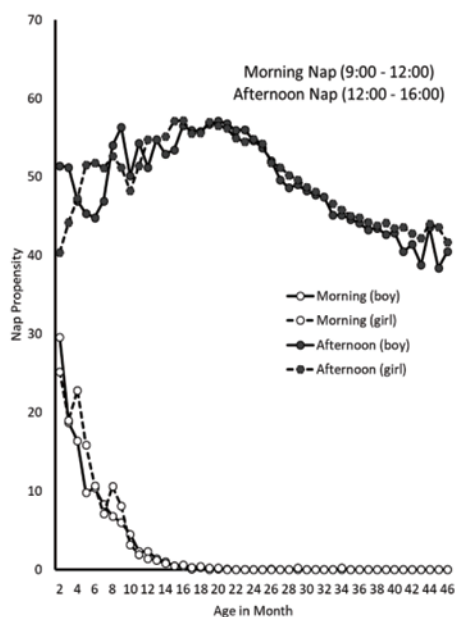


Fig.1 Diurnal nap propensity in morning and afternoon period until 46th month after birth.

## Results and Discussion

**Overall Developmental Process of Morning and Afternoon Naps:** Fig. 1 shows the transition of sleep tendency for the morning (9:00 to 12:00) and for the afternoon (12:00 to 16:00) naps. The results for the boys and the girls were shown separately, but there was no clear difference between the results for the boys and the girls. Daytime sleep in the morning was basically short, which is also shown as a sleep propensity in this figure. It can also be seen that daytime sleep in the morning almost disappeared by the age of 1 year (12 months) and totally disappeared by at least 1 and a half years (18 months). On the other hand, it can be seen that daytime sleep in the afternoon gradually increased after birth, peaked at about one and a half years (18 months), and then gradually decreased.

**Process of convergence of afternoon daytime sleep:**

Fig. 2 shows the transition of the amount (minutes) of daytime naps in the afternoon. The figure shows the change in the total amount of daytime sleep from 12:00 to 16:00 and the change in the total amount of daytime sleep from 13:00 to 15:00 for each gender. The total amount of daytime nap from 12:00 to 16:00 showed a tendency to peak at 18 months and then gradually decreased, similar to the sleep tendency shown in Figure 1. On the other hand, the total amount of daytime nap from 13:00 to 15:00 increased until 18 months then seemed to maintain a relatively constant value (about 100 minutes). From the results shown above, the pattern of decrease of afternoon daytime nap after 18 months was caused by disappearance of naps outside of the narrower time zone (13:00 to 15:00) and concentration of the naps into the narrower time zone.

Fig. 3 shows the ratio of daytime sleep amount to 13:00 to 15:00 (narrower time period) out of the daytime sleep amount that occurred from 12:00 to 16:00 (broader time period). After 3 years of age (36 months), the afternoon daytime sleep is almost 100% concentrated in the narrower time period (13:00 to 15:00). As shown in the Fig. 2, after the afternoon daytime nap concentrated in the narrower time zone (13:00 to 15:00) around 3 years (36 months), the amount of afternoon daytime nap again gradually declined.

**Conclusions:** As mentioned above, daytime nap in the morning almost disappeared at 12 months after birth and completely disappeared by 18 months, while daytime nap in the afternoon peaked quantitatively at 18 months and then gradually decreased. The pattern of decrease consisted from disappearance of nap outside of the narrower time zone (13:00 to 15:00) and concentration of nap in the narrower time zone.

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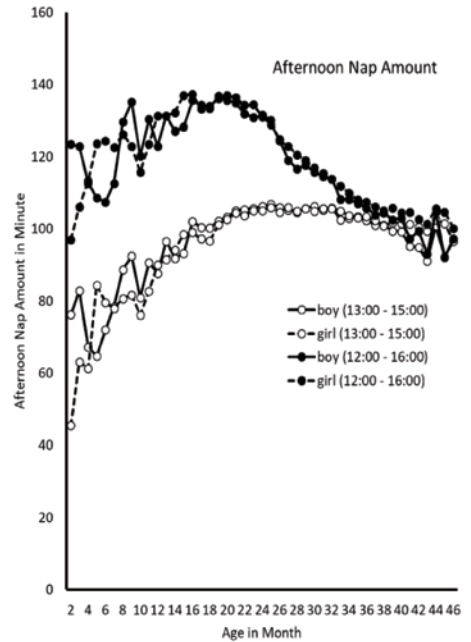


Fig.2 Mean amount (min.) of afternoon nap per day during broad (12:00 to 16:00) and narrow (13:00 to 15:00) time periods.

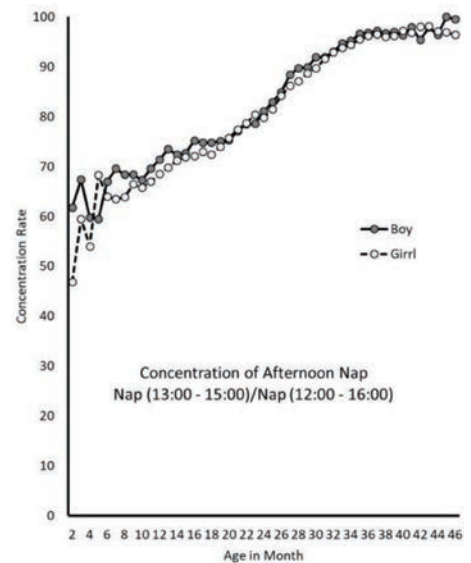


Fig.3 Concentration of afternoon naps into the narrow time period (13:00 to 15:00).

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