The effects of 120-minute nap during simulated 16 h night work: a pilot study

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Study Objectives

To systematically investigate performance, subjective sleepiness, and fatigue for the first time. Following a 120-minute nap starting at 22:00, 00:00, or 02:00, we tested the following two hypotheses in this study.

Background

In Japan, many nurses work on two- or three-shift systems. In two-shift systems, there are two major forms of night shifts: 12-hour shifts and 16-hour shifts (Table 1). In particular, 16-hour night shifts are a burden for nurses both physically and mentally. Previous research has indicated that nurses on such schedules are troubled by morning sleepiness and fatigue, which can increase the risk of traffic accidents after work.

There is an interest in the effects of taking a nap during the night shift as a means of recovering from night shift fatigue. Several studies have indicated that napping can reduce sleepiness and maintain the efficiency of workers. It is common for nurses to nap between 22:00 and 06:00. However, the effects of napping differ depending on the duration and starting time of the nap.

Table 1. Shift work time schedule in Japan

	08:00	16:00	21:00	00:00	09:00
2-shift system	8 hour day shift		16 hour night shift		
	12 day shift			12 night shift	
3-shift system	day shift		afternoon shift		night shift

Measurements

The participants were 14 females (age range 21.7±0.9 years).

Three experimental nap conditions were used: naps from 22:00 to 00:00 (22:00-NAP), 00:00 to 02:00 (00:00-NAP), and 02:00 to 04:00 (02:00-NAP), respectively. Measurement items were sublingual temperature, a Visual Analog Scale for sleepiness and fatigue, and single-digit addition calculations (for 10 minutes) every hour for 17 hours from 16:00 to 09:00, excluding nap times. Heart rate variability was measured by electrocardiogram, and participants wore an ActiGraph to estimate sleep quality. This study was approved by the Ethics Committee for Epidemiologic Research at Okayama University Graduate School of Health Sciences. All participants provided informed consent prior to study involvement.

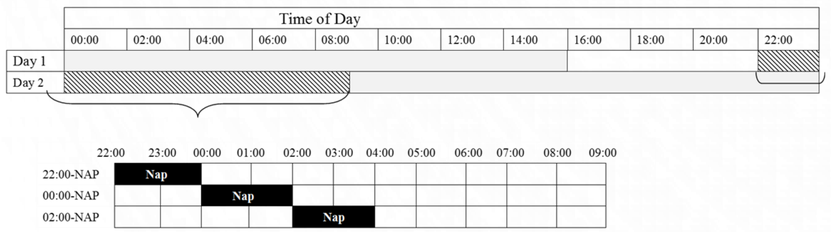

Fig. 1. Schematic of the study protocol. Each row represents 24 hours.
The black areas indicate nap times. The diagonal hatching shows all three conditions during that time period.

Results and Discussion

The average wake-up time on the experiment days was 09:04 (01:02) in the 22:00-NAP, 08:58 (01:23) in the 00:00-NAP, and 08:42 (00:58) in the 02:00-NAP (F (2, 39)=0.387, p=.682), with no significant difference among the three conditions. Moreover, there were no significant differences in baseline variables (at 21:00) on the day of the experiment among conditions.

No significant differences were observed among total sleep time, wake after sleep onset, sleep efficiency and autonomic nervous system activity for any of the three nap conditions when naps were taken on various days. However, among the 14 participants, three participants in the 22:00-NAP and two participants in the 02:00-NAP could not sleep, and their sleep latency as measured by the ActiGraph was over 30 minutes.

Table 2. Results from the linear mixed-effects analysis of variance for neurobehavioral outcomes.

	00:00 to 02:00 (22:00-NAP vs 02:00-NAP)			02:00 to 04:00 (22:00-NAP vs 00:00-NAP)			04:00 to 09:00 (22:00-NAP vs 00:00-NAP vs 02:00-NAP)		
	df	F	*p*value	df	F	*p*value	df	F	*p*value
Temperature									
Condition	1,65	.190	.665	1,65	.187	.667	2,221	6.956	.001
Time	2,65	.199	.820	2,65	6.804	.002	5,221	2.716	.021
Condition*Time	2,65	3.152	.049	2,65	1.269	.288	10,221	.720	.705
Sleepiness									
Condition	1,65	.339	.563	1,65	.497	.483	2,221	19.329	<.001
Time	2,65	.660	.520	2,65	.926	.401	5,221	5.839	<.001
Condition*Time	2,65	4.132	.020	2,65	2.930	.060	10,221	2.114	.024
Fatigue									
Condition	1,65	1.417	.238	1,65	1.277	.263	2,221	26.185	<.001
Time	2,65	2.218	.117	2,65	.735	.484	5,221	9.331	<.001
Condition*Time	2,65	.753	.475	2,65	1.556	.219	10,221	1.434	.167
	00:00 to 01:00 (22:00-NAP vs 02:00-NAP)			02:00 to 04:00 (22:00-NAP vs 00:00-NAP)			04:00 to 09:00 (22:00-NAP vs 00:00-NAP vs 02:00-NAP)		
Performance	df	F	*p*value	df	F	*p*value	df	F	*p*value
Condition	1,39	.551	.462	1,65	.308	.066	2,221	12.457	<.001
Time	1,39	.608	.440	2,65	1.158	.321	5,221	8.974	<.001
Condition*Time	1,39	2.411	.129	2,65	2.839	.066	10,221	1.843	.055

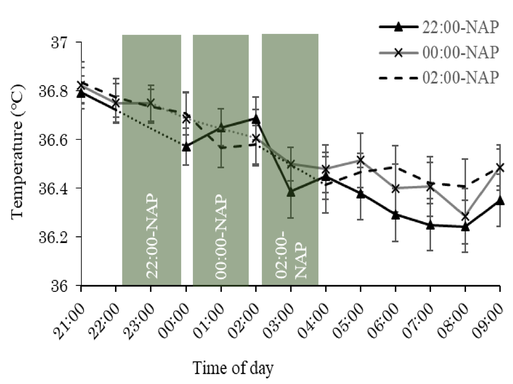

Fig. 2. Mean (± standard error of the mean) for temperature.

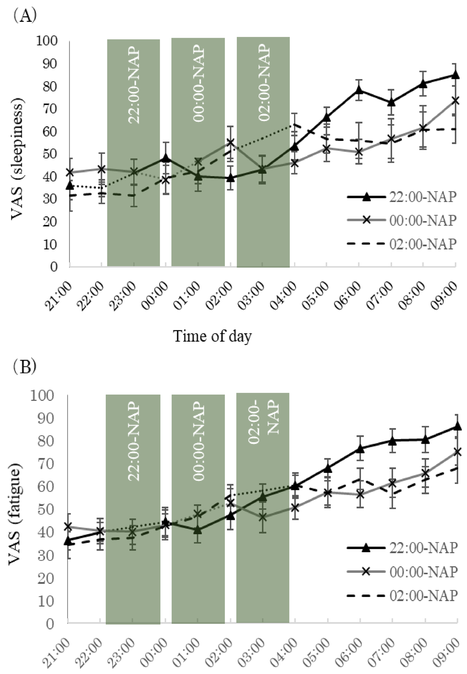

Fig. 3. Mean (± standard error of the mean) for subjective (A) sleepiness and (B) fatigue. VAS, Visual Analog Scale.

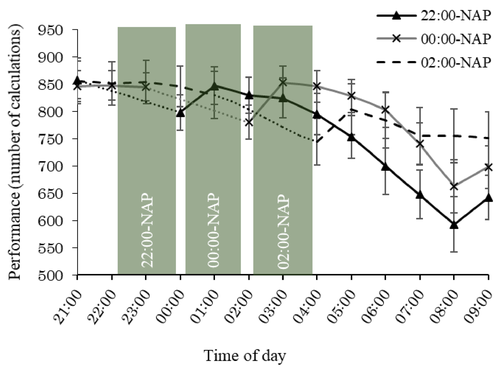

Fig. 4. Mean (±standard error of the mean) for number of calculations performed.

In the 22:00-NAP condition, the temperature increased with at 03:00, and the sleepiness, fatigue, and performance worse at 04:00. The 22:00-NAP inhibited sleepiness and performance deterioration through 04:00. In the 00:00-NAP on the other hand, the effect of napping was sustained through 06:00. Between 06:00 and 09:00, the temperature was significantly lower in the 22:00-NAP than in other conditions, sleepiness and fatigue increased.

The number of calculations performed was significantly better in the 00:00-NAP and the 02:00-NAP than in the 22:00-NAP, showing that performance was sustained during 06:00 to 09:00. Thus, the subjective fatigue at 02:00 to 06:00 suggests that a later nap will better sustain performance in the early morning compared to an earlier nap. Moreover, if decreases in sleepiness and fatigue and sustained performance are to be expected from 06:00 to 09:00 in the 22:00-NAP, it may be necessary to add a short nap between 04:00 and 06:00.

In workplace scenarios where there is an opportunity for long breaks (> 2 h), longer naps may produce benefits immediately and over longer times.

Conclusion

This is the first study to investigate whether 120-minute naps ending at 00:00, 02:00 and 04:00 have an effect of sleepiness, fatigue and performance from 16:00 to 09:00. It was suggested that a 120-minute nap at night (22:00 to 04:00) provides the same sleep state regardless of the start time. Also, sleepiness and fatigue did not change immediately after a nap, but performance was decreased. The nap effects of suppressed sleepiness and fatigue lasted 6 to 7 hours.

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