Subjective and Objective Napping and Sleep in Older Adults: Are Evening Naps 'Bad' for Nighttime Sleep?

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Abstract

Objectives—To compare objective and subjective measurements of napping, and to examine the relationship between evening napping and nocturnal sleep in older adults.

Design—For twelve days, participants wore actigraphs and completed sleep diaries.

Setting—Community

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Conflict of Interest Disclosures:

Elements of Financial/Personal Conflicts	* Author 1 Natalie Dautovich		Author 2 Christina McCrae		Author 3 Meredeth Rowe		Etc.	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Employment or Affiliation		X		X		X		
Grants/Funds		X	X			X		
Honoraria		X		X		X		
Speaker Forum		X		X		X		
Consultant		X		X		X		
Stocks		X		X		X		
Royalties		X		X		X		
Expert Testimony		X		X		X		
Board Member		X		X		X		
Patents		X		X		X		
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For "yes" x mark(s): give brief explanation below:

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Participants—100 individuals who napped, 60–89 years (including good and poor sleepers with typical age-related medical comorbidities).

Measurements—Twelve days of sleep diary and actigraphy provided subjective and objective napping and sleep data.

Results—Evening naps (within 2 hours of bedtime) were characteristic of the sample with peak nap time occurring between 20:30–21:00 (average nap time occurred between 14:30–15:00). Two categories of nappers were identified: 1) day/evening – those who took both daytime and evening naps, and 2) daytime-only. Interestingly, no participants napped during the evening only. Day/evening nappers significantly underreported evening napping and demonstrated lower objectively measured sleep onset latencies (20 vs 26.5 minutes), less wake after sleep onset (51.4 vs 72.8 minutes), and higher sleep efficiencies (76.8 vs 82%) than daytime-only nappers.

Conclusion—Day/evening napping was prevalent amongst this sample of community-dwelling good/poor sleepers, but was not associated with impaired nocturnal sleep. Although the elimination or restriction of napping is a common element of cognitive-behavioral therapy for insomnia (CBTi), these results suggest that a uniform recommendation to restrict/eliminate napping (particularly evening napping) may not meet the needs of all older individuals with insomnia.

INTRODUCTION

A significant challenge facing 57% of older adults is difficulty sleeping[1]. The impact of insomnia on older individuals ranges from a minimum impact of daytime fatigue to impaired cognitive functioning[2]. Late-life insomnia is attributable, in part, to age-related changes in sleep architecture resulting in lighter sleep, more awakenings, less total sleep time, and longer sleep onset[3]. Despite these structural changes, sleep complaints are not universal and are minimal in healthy older adults[3]. For many older individuals, health, situational, and psychological factors combine and add to ontogenetic changes affecting sleep.

Napping, a situational factor associated with late-life insomnia[4], is prevalent[5] with 1 in 4 older adults napping daily[2, 6]. Average nap frequency in older adults is one/week[7], and average duration is 23.3[7]–45[8] minutes/day. Clinically, napping is often considered to negatively impact sleep. For example, the sleep hygiene component of cognitive-behavioral treatments for insomnia (CBTi) typically recommends eliminating/reducing napping. However, empirical evidence on the impact of napping on nighttime sleep is mixed – calling this recommendation into question. Although a large portion of the literature failed to find an association between napping and sleep, other studies found negative associations[6, 9–11,5] and still others found positive associations[2,10–12].

The present study employs several innovations in its examination of the relationship between napping and sleep in older adults. First, methodological factors, such as measurement type (objective/subjective) and brief measurement periods, may have

contributed to previous inconsistent findings. Past research relied heavily on surveys or diaries/logs, and evidence suggests older individuals may underreport their napping[8, 13]. Additionally, previous research relied on limited data collection periods which may not accurately capture the variability in older adults' napping. Approximately 50% nap only 1–2 days/week[6] with considerable variability from weekdays to weekends[12]. *The study's first aim is to further explore the relationship between objective/subjective napping and to more accurately capture the variability in older adults' napping habits.* This is accomplished by examining both self-reported and actigraphically-measured napping over an extended period of time (12 consecutive days–twice as long as the previously reported maximum of 6 days[7, 13]) in community-dwelling older adults.

A second innovation involves the examination of multiple facets of napping (frequency, duration, and timing) within a single study. In previous research, the average time of day of napping in older adults ranged from 13:34[14]–22:00[7]. Interestingly, a number of researchers identified a subset of napping-the evening nap[13]. Frequency of evening napping increases with age[7, 8, 10], and prevalence rates in the elderly range from 45–52%[15, 16]. Yoon and colleagues[13] found that the evening nap timeframe corresponded to clock-times of 20:38–22:38 while the average evening nap duration ranged from 5[15]–31.3 minutes[7].

Clinically, the sleep hygiene recommendation to reduce/eliminate napping is commonly modified to permit a brief nap earlier in the day[17]. The rationale behind this is that early naps are less likely to interfere with nighttime sleep. However, empirical support for this is mixed [13,8,18]. *The study's second aim is to examine the impact of evening naps on sleep in older adults.* This is accomplished by comparing nighttime sleep variables (objective and subjective total sleep time, sleep onset latency, wake after sleep onset, and sleep efficiency) in two groups–daytime-only nappers and day/evening nappers.

In comparison to previous research which examined napping in an unusually healthy sample[13], the current sample contained older individuals with both health complaints and insomnia complaints (good/poor sleepers). Additionally, by conducting general community-based recruitment and sampling participant behavior within the home environment, the present study's results have greater ecological validity and enhanced generalizability.

METHODS

Procedure

A secondary data analysis was performed using data previously collected[19]. Participants were recruited from North Florida using media advertisements, community groups, and flyers. Recruitment materials advertised a study of normal sleep patterns and encouraged all types of older sleepers (good, poor, in-between) to participate. Participants received $30 USD. Screening consisted of a brief telephone interview (15–20 minutes) followed by a 1–1 ½ hour interview either at home (76%) or a local continuing care retirement center (24%).

Exclusionary criteria: 1)<60 years; 2)self-reported sleep disorders other than insomnia (apnea, narcolepsy); 3)self-reported symptoms of sleep diagnoses other than insomnia (e.g., heavy snoring, gasping for breath); 4)severe psychiatric disorder (thought disorder,

depression); 5)cognitive impairment (impaired score on 3+ Cognistat subtests); 6)use of psychotropic/other sleep-altering medications (beta-blockers); 7)medical conditions that impaired independent daily functioning[19].

Following consent, the Cognistat, and demographics/health survey were administered. Next, participants were asked to complete sleep diaries and wear the Actiwatch-L® (data download at end of each week) continuously for 14 days.

Participants

Of the 116 individuals recruited, 103 were enrolled. Thirteen individuals were ineligible due to age, dementia, medication, and sleep apnea. See Table 1 for demographic characteristics. All participants lived in their own homes. The sample included good and poor sleepers. Participants were categorized as poor sleepers if they reported 31 minutes of unwanted awake time during the night (sleep onset latency or wake after sleep onset) 3 nights/week.

Measures

Objective sleep—Participants wore an Actiwatch-L®[20] on their nondominant wrist for 14 consecutive 24-hr periods concurrent with the sleep diary period. Within the Actiwatch-L®, an omnidirectional, piezoelectric accelerometer with a sensitivity of 0.01 g-force samples data 32 times/second over a 30 second epoch. Data is then analyzed by Actiware-Sleep vol. 3.3[20]. A high sensitivity setting was used since it provides high correlations with PSG-measured total sleep time (.95) for healthy older adults[21] and for total sleep time (.73) and sleep onset latency (.93) for individuals with insomnia[22]. Additionally, actigraphy has high criterion-validity compared to PSG (.80) and high test-retest reliability[23] (0.92).

Four objective sleep variables were obtained: sleep onset latency$_o$-interval between bedtime and sleep start; total sleep time$_o$-sum of all sleep epochs within a sleep period; sleep efficiency$_o$-ratio of total sleep time to total time-in-bedx100%; and wake after sleep onset$_o$-time spent awake after initial sleep onset until last awakening. Note: Throughout this report, the subscripts "s" and "o" are used to distinguish between the subjective and objective variables.

Subjective sleep—Participants completed sleep diaries[24] each morning for 14 days. However, the first and last days were not analyzed as the actigraphy data for those days was incomplete. Four subjective sleep variables were obtained: sleep onset latency$_s$-initial time from lights out until sleep onset; wake after sleep onset$_s$-time spent awake after initial sleep onset until last awakening; total sleep time$_s$-computed by subtracting total wake time from time-in-bed; and sleep efficiency$_s$-ratio of total sleep time to total time-in-bedx100%.

Objective napping—Napping was measured objectively using actigraphy. Methodological questions have arisen regarding the sensitivity of actigraphy to distinguish inactivity due to napping versus resting or watch removal. Interestingly, the sensitivity setting (high) validated for determining sleep bouts in older adults is not applicable for identifying napping. A threshold of 20 activity counts per 30 second epoch resulted in an overestimation of napping, due in part to the misidentification of inactivity (resting/watch

removal) as sleep bouts. Therefore, an even higher sensitivity setting was required in order to differentiate mere inactivity from napping. A sensitivity setting of 12 enabled the detection of naps identified by participants in their sleep diaries. Convergent validity for the sensitivity setting was established by comparing objective/subjective naps of participants who kept detailed sleep diaries (e.g. nap 2:30–2:45).

Additionally, concerns about differentiating resting/watch removal from napping were addressed by examining narratives in the participants' sleep diaries ("watch removed from 6–8 p.m.") and applying Webster's rules[25]. To further ensure the differentiation of 'watch off' periods from napping, the sensitivity level was increased to the highest setting (0) and periods which were still identified as naps were noted. If a period of inactivity was labeled as a nap at this setting, it was eliminated from analysis. An activity count of '0' contains less activity then required for sleep and actually represents 'watch off' intervals.

Finally, to encompass the nap durations of 5[15] to 45[8] minutes found in previous research, naps ranging from 5–180 minutes were included in the analysis. By including naps of >5 minutes, the ability to detect 'watch off' periods was increased as the detection of '0' activity for >5 minutes could only be attributed to watch removal.

Five objective napping variables were obtained: frequency-days napped$_o$-average number of days out of 12 on which a nap occurred; frequency-# of naps$_o$-average number of naps that occurred on a given day when the participants napped; duration-overall$_o$-average total time spent napping on the days that participants napped; duration-per nap$_o$-average time spent napping during each nap; and time of day$_o$-sum of the time of day of all naps for each participant divided by the number of naps taken.

Time of day of nap categories—The actigraphic data were used to categorize participants into 2 groups: day/evening nappers (napped during both the day and evening) and daytime-only nappers (solely napped during the day). A nap was labeled an evening nap if it occurred within two hours of the individual's bedtime for the day being considered[13].

Subjective napping—Participants recorded the total number of minutes spent napping each day on their sleep diaries. Two subjective napping variables were obtained: frequency-days napped$_s$-average number of days during which participants self-reported napping; duration-overall$_s$-average total time spent napping on days napping was reported.

Demographics/Health survey—This two-page, 13-item questionnaire collects information on demographics, sleep disorder symptoms, physical health, and mental health[26]. The sleep disorders items asked whether the participant had a sleep problem and if they or a bed partner noticed heavy snoring, difficulty breathing or gasping for breath, frequent leg jerks, restlessness before sleep onset, sleep attacks during the day, or paralysis at sleep onset.

Cognitive impairment—Participants were screened for cognitive impairment using the Cognistat[27]. Individuals who scored in the impaired range on three or more of the ten subscales were excluded. The Cognistat has been found to more sensitively detect cognitive-

impairment than the MMSE[28] and to differentiate between impairment due to psychiatric illness versus impairment due to organic cognitive impairment[29]. Interrater reliability ranges from 0.997–1.00[30].

Statistical Analysis

Paired samples *t* tests were conducted to examine differences in objectively and subjectively measured napping variables. Significance was defined at a Bonferroni-adjusted alpha level of 0.025 (*t* tests) and 0.013 (chi-square tests). Two MANOVAs were conducted to examine differences between the 2 nap groups (daytime-only versus day/evening) in objectively and subjectively measured sleep variables. Additionally, two MANOVAs were performed to examine group differences in sample and nap characteristics. Finally, chi-square analyses were performed to examine group differences in the categorical sample variables (gender, marital status, ethnicity, sleep classification).

RESULTS

Sample and Nap Characteristics

There were no significant group differences [Wilk's Λ=.86, $F(8, 71)$=1.41, p=.21, η^2=0.14] in terms of age, education, number of medications, health conditions, or average bed/waketimes. The nap groups also did not differ in terms of gender (p=0.35), marital status (p=0.44), race (p=0.05), or sleep classification (good/poor sleepers; p=0.11). See Table 1.

Three individuals were excluded from the analysis as they did not engage in napping throughout the study. Nap frequency-days napped$_o$ was significantly higher than nap frequency-days napped$_s$ ($t[98]$=−4.74, p=.000, η^2=0.19). Conversely, nap duration-overall$_s$ was significantly longer than nap duration-overall$_o$ ($t[96]$=2.174, p<.002, η^2=0.05).

Peak time of day of naps recorded by actigraphy occurred between 20:30–21:00 p.m. (see Figure). *Average* time of day of naps was between 14:30–15:00. Forty-seven percent of all naps occurred after 6 p.m. Fifty-eight percent of the sample engaged in an evening nap and 85% engaged in a daytime nap. There were no significant gender differences in nap frequency, duration, or time of day.

There were significant nap group differences in napping [Wilk's Λ=.62, $F(7, 71)$=6.24, p=.000, η^2=0.38]. Univariate follow-up tests indicated the groups differed in frequency-days napped $_o$ [$F(1, 77)$=26.70, p=.000, η^2=0.26], nap frequency-# of naps$_o$ [$F(1, 77)$=14.85, p=.000, η^2=0.16], nap duration-overall $_o$ [$F(1, 77)$=8.66, p=.004, η^2=0.10], and time of day $_o$ [$F(1, 77)$=8.29, p=.005, η^2=0.10]. Day/evening nappers had a higher nap frequency both per day and over the 12 day period compared to daytime-only nappers. On average, daytime-only nappers had naps of significantly longer duration while day/evening nappers engaged in naps later in the day.

Nap Categories and Objective Sleep Quantity

Fifty-eight percent of participants were categorized as day/evening nappers, and 27% were daytime-only nappers. The remaining 15% of the sample exhibited very low frequency napping behavior (0–2 naps over the 12 day period). 000Overall, there was a significant

main effect of group [Wilk's Λ=.81, $F(4, 77)$=4.82, p=.003, η^2=0.19]. Univariate followup tests revealed significant differences for sleep onset latency$_o$ [$F(1, 80)$=4.37, p=.04, η^2=0.05], wake after sleep onset$_o$ [$F(1, 80)$=14.27, p=.000, η^2=0.15], and sleep efficiency$_o$ [$F(1, 80)$=12.01, p=.001, η^2=0.13]. Day/evening nappers had significantly lower sleep onset latencies (7 minutes), less wake after sleep onset (21 minutes), and greater sleep efficiencies (5%) as measured by actigraphy compared to daytime-only nappers. See Table 2.

Nap Categories and Subjective Sleep Quantity

There was no significant main effect of group [Wilk's Λ=.93, $F(12, 222.535)$=0.50, p=.95, η^2=0.25]. There was a significant correlation between self-reported versus actigraphically-measured nap duration for daytime-only ($r = .39$, p=.0103), but not for day/evening nappers ($r = .16$, p=.36). See Table 2.

DISCUSSION

The present study examined the relationship between napping and sleep in community-dwelling older adults who napped. The first aim examined differences between subjectively and objectively measured napping, and the results revealed interesting differences for both frequency and duration. Specifically, subjective nap frequency (4 naps over 12 days) was consistent with previous research[12], while objective nap frequency (6 over a 12 day period) was considerably higher[12,7]. A possible explanation is that actigraphy may be capturing a greater number of evening naps than the sleep diary. Yoon and colleagues[13] found only 22.6% of evening nappers self-reported their evening naps. The present study supports and extends these findings as there was a significant underreporting of nap durations by day/evening nappers (more than two and a half times) compared to daytime-only nappers. Regarding nap duration, previous studies reported ranges from 23.3–45 minutes/day[7, 8, 13, 14, 16]. Average objective (13 minutes) and subjective (18) nap durations in this study were comparatively lower. One explanation for this is that the inclusion of evening naps (typically of shorter duration than daytime naps) would decrease the mean duration.

Time of day of napping was also examined with peak nap time occurring between 8:30–9:00 p.m. This is consistent with previous studies that found the evening to be the most characteristic time for napping in older samples[8, 13, 15, 16]. One theoretical explanation for the large number of evening naps in the present sample is that evening napping may represent an advance in circadian rhythms. Some older adults experience a 'phase advance' resulting in earlier bed- and waketimes[13]. Therefore, out-of-bed sleep in the evening could represent the start of the nocturnal sleep period. In the present sample, however, there was not a significant difference in bedtimes between the day/evening and daytime-only nappers. Alternatively, evening napping may represent a weakening of the alerting signal from the suprachiasmatic nucleus (SCN),[16] which regulates the sleep/wake cycle. Action potentials within the SCN fire in a 24-hour rhythm and reach a maximum firing at mid-day and then fall again at night. It is possible that evening naps could result from a premature drop in the firing of SCN action potentials reducing the alertness of the individual. While there was not a statistically significant difference between the nap groups in terms of medication or conditions, the day/evening nap group reported almost double the number of medical

conditions of the daytime-only nap group. It is possible that with greater power, a significant difference in medical conditions would have been detected which could also explain the large number of evening naps in the day/evening nap group. Finally, the large number of evening naps could simply reflect greater sleep needs or trait sleepiness in the present sample.

The second aim examined the relationship between evening naps and sleep. Day/evening and daytime-only nappers differed significantly in terms of objective sleep. Essentially, day/evening nappers had significantly less wake time during the night compared daytime-only nappers. This result conflicts with conventional sleep hygiene recommendations to avoid napping altogether or restrict naps to before noon[17], but is consistent with recent recommendations to evaluate the cost/benefits of napping on an individual basis[18].

In addition to being statistically significant, the results are clinically significant. An average wake after sleep onset of 31 minutes can result in an insomnia diagnosis. Therefore, a 21 minute decrease in wake after sleep onset and a 5% increase in sleep efficiency can have significant clinical impact for elderly sleepers.

Comparisons of the two nap groups revealed interesting differences. Day/evening nappers had a higher nap frequency (both daily and over the 12 days), shorter average duration, and a later average nap time compared to daytime-only nappers. It is intuitive that by engaging in naps during the day/evening, this group likely had a higher frequency of napping. Conversely, napping for longer durations and earlier in the day (daytime-only group) was not associated with better objective sleep.

One limitation of the study is the use of a convenience sample, which restricted generalization of the results to a more diverse sample. Interestingly, comparisons between nappers and non-nappers were prevented, because only 3 out of 103 individuals enrolled did not nap. Because the sample was highly educated and relatively healthy, the napping behavior reported herein may be an underestimation of napping in less healthy, less educated older adults. A second limitation is that the study's cross-sectional design makes it impossible to draw causal conclusions. Finally, the two measures of napping (objective and subjective) employed have strengths and weaknesses. While actigraphy provides a sensitive measure of an individual's napping, it is a novel approach that has not typically been applied to the study of napping. Sleep diaries have been used before, but have limited utility for assessing nap duration and time of day of napping.

Future research directions include the establishment of reliability data for both objective and subjective measures of napping. Additionally, the relationship between napping and sleep could be further defined by examining the intraindividual (within-person) variability of napping. This study examined the relationship between napping and sleeping behaviors in community-dwelling older adults who engaged in napping. Significant differences were found between objective and subjective measures of napping. Evening was the most characteristic time for napping. The combination of day/evening naps was not associated with impaired nocturnal sleep. As these results run counter to prevailing treatment recommendations, further research is needed to replicate them, and to subsequently arrive at

a consensus regarding treatment recommendations for napping in older adults with insomnia.

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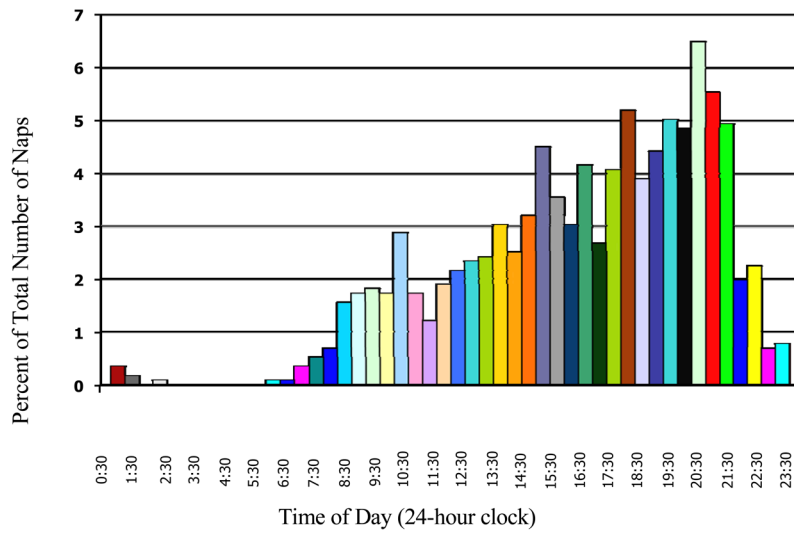
Figure 1.
Percentage of total actigraphically-measured naps taken by all participants that occurred during each half-hour interval of the 24-hour clock.

Table 1

Participant Demographics and Sleep and Napping-Related Characteristics for Overall Sample and by Nap Groups

	Overall Sample	Day/evening nappers	Daytime-only nappers
Age ($M \pm SD$)	72.95 (6.93)	73.33 (7.33)	72.86 (6.76)
Education (years, $M \pm SD$)	16.16 (3.05)	16.31 (2.96)	15.73 (2.86)
Gender (% Female)	64.00	61.70	72.70
Marital Status (%)			
Single	6.00	5.70	11.80
Married	71.10	69.80	70.60
Widowed	14.50	18.9	5.90
Divorced	8.40	5.70	11.80
Ethnicity (%)			
Caucasian	97.00	98.30	90.90
African American	2.00	0	9.10
Other	1.00	1.70	0
Medications[1] ($M \pm SD$)	2.92 (2.19)	3.133 (2.21)	2.59 (1.98)
Conditions[2] ($M \pm SD$)	2.03 (1.60)	2.28 (1.77)	1.32 (1.13)
Sleep Classification (%)			
Good Sleepers	59.00	65.00	45.40
Poor Sleepers	41.00	35.00	54.60
Bedtime ($M \pm SD$)	22:22 (79 mins)	22:17 (81 mins)	22:58 (42 mins)
Wake time ($M \pm SD$)	6:48 (49 mins)	6:45 (48 mins)	7:25 (50 mins)
Napping Behavior ($M \pm SD$)			
Nap frequency-days napped$_o$[3]	6.16 (2.87)	7.13[a] (2.68)	3.67[a] (2.06)
Nap frequency-days napped$_s$[3]	4.26 (3.31)	3.88 (3.23)	5.32 (3.75)
Nap frequency-# of naps$_o$[4]	1.72 (0.65)	1.20[b] (0.83)	0.43[b] (0.30)
Nap duration-overall$_o$[5]	13.15 (2.82)	13.52[c] (3.35)	12.57[c] (1.89)
Nap duration-overall$_s$[5]	18.11 (21.91)	18.93 (25.76)	19.82 (15.25)
Nap duration-per nap$_o$[6]	8.52 (2.97)	7.88 (2.81)	10.19 (3.29)
Time of day$_o$[7]	14:52 (142 mins)	16:48[d] (100 mins)	15:21[d] (187 mins)

Note. The subscript '$_o$' denotes objectively (actigraphically) measured variables while the subscript '$_s$' denotes variables measured subjectively (sleep diaries).

[1] Total number of medications participants listed.

[2] Total number of medical conditions from the following list: heart problems, cancer, hypertension, neurological disorder, breathing disorder, urinary problems, diabetes, pain, gastrointestinal disorders, mental health disorder, and other.

[3] Nap frequency-days napped refers to the average number of days out of the 12 assessment days when the participant napped;

[4] Nap frequency-# of naps refers to the average number of naps that occurred on a given day;

[5] Nap duration-overall refers to the average total time in minutes spent napping on the days the participants napped;

[6] Nap duration-per nap refers to the average time in minutes spend napping during each nap;

[7] Time of day of naps is calculated as a serial number equivalent to the 24hr clock (0=12am, 0.5=12noon, and 1.0=12 midnight)

[a,b] Means with different subscripts differ significantly at $p < .001$.

[c,d] Means with different subscripts differ significantly at $p < .01$.

Table 2

Means and Standard Deviations for the Time of Day of Nap Groups for Objective and Subjective Sleep

Actigraphy sleep and nap variables

Nap Group	SOL (mins) M	SD	WASO (mins) M	SD	SE (%) M	SD	TST (mins) M	SD
Daytime-only	26.50*	13.01	72.82†	24.65	76.80§	6.41	382	43.04
Day/evening	20.00*	12.28	51.43†	21.99	81.95§	5.80	393	58.71

Sleep Diary sleep and nap variables

Nap Group	SOL (mins) M	SD	WASO (mins) M	SD	SE (%) M	SD	TST (mins) M	SD
Daytime-only	25.61	16.74	25.19	23.50	86.05	6.65	430	46.89
Day/evening	23.92	19.73	28.72	26.28	84.97	9.43	408	69.02

Note: SOL (sleep onset latency) refers to the number of minutes spent awake from bedtime to the onset of sleep; WASO (wake after sleep onset) refers to the total number of minutes spent awake during the night excluding SOL; SE (sleep efficiency) is a ratio of the time spent sleeping to the time spent in bed; TST (total sleep time) refers to the time spent asleep during the night excluding SOL and WASO.

*
Group means were significantly different, $p<.05$.

†
Group means were significantly different, $p<.001$.

§
Group means were significantly different, $p<.01$.