Sleep Problems, Fatigue, and Cognitive Performance in Chinese Kindergarten Children

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Objective To examine sleep problems and fatigue and their associations with cognitive performance in Chinese kindergarten children.

Study design A cross-sectional analysis of baseline data from Jintan Child Cohort Study was conducted, which includes a cohort of 1656 kindergarten children in Jintan City, Jiangsu Province, China. The sample used in the current study consisted of 1385 children (44.8% girls, mean age 5.72 [SD = 0.42] years) for whom data on sleep problems or cognitive performance were available. Child Behavior Checklist was used to measure child sleep problems and fatigue, and Wechsler Preschool and Primary Scale of Intelligence–Revised was used to assess child IQ.

Results Sleep problems were prevalent, ranging from 8.9% for difficulty maintaining sleep to 70.5% for unwilling to sleep alone. Other reported sleep problems were difficulty initiating sleep (39.4%), nightmares (31.6%), sleep talking (28%), sleeping less (24.7%), and sleep resistance (23.4%). Fatigue was also prevalent, with 29.6% of children reported to be overtired and 12.6% lack of energy. Children with difficulty maintaining sleep, sleep talking, sleep resistance, or nightmares scored 2-3 points lower in full IQ than children without sleep problems. Children reported to have fatigue scored 3-6 points lower in full IQ than those children without fatigue.

Conclusions Sleep problems and fatigue are prevalent in Chinese kindergarten children. Furthermore, sleep problems and fatigue are associated with poor cognitive performance. *(J Pediatr 2012;161:520-5)*.

Sleep problems are highly prevalent in pediatric populations. Studies from around the world demonstrate that 10%-50% of school-aged children experience some sort of sleep problem or disorder.[1-5] Several studies have examined sleep problems in Chinese school-aged children.[6-10] Liu et al found that among 2000 Chinese elementary school children, the prevalence of parent-reported sleep problems, including nightmares, sleep walking/talking, and difficulty sleeping, to be lower than those in Western samples.[8] Conversely, recent studies have reported that sleep problems in school-aged children are more prevalent in China than in Western countries,[6,7] possibly due to the prevalence of co-sleeping behavior in Chinese families.[11] In a comparative study of sleep problems, Chinese children were reported to have more sleep problems and slept 1 hour less per day than American peers.[9] A recent cross-cultural study also reported that Chinese infants and toddlers had significantly later bedtimes, shorter total sleep durations, and increased parental perception of sleep problems than Western children.[12] However, little has been done to assess sleep problems in Chinese kindergarten-aged children.

The impact of sleep disturbance in young children (eg, ages 4-6 years) on cognitive functioning and the developing brain is a serious concern. Sleep disturbances have been linked to a variety of neurocognitive problems in children. For instance, it may significantly reduce glucose metabolism in the thalamic, prefrontal, and posterior parietal regions, thereby impinging on alertness and attention, impairing restorative processes, and resulting in prefrontal cortex dysfunction and subsequent difficulties in executive functioning, impulsivity, and working memory.[13-15] Fatigue and sleepiness are further associated with cognitive deficits, such as processing, motor speed, and academic performance.[16]

The relationship between sleep, cognition, and academics remains inconsistently documented.[17,18] This study aims to address the gaps in the literature, first by assessing the prevalence of sleep problems and fatigue in a large, community sample of Chinese kindergarten children using the well-established Child Behavior Checklist for Preschool Children (CBCL) and secondly, by using the Chinese Wechsler Preschool and Primary Scale of Intelligence–Revised[19,20] to examine whether sleep problems are associated with poor cognitive performance in this sample.

CBCL	Child Behavior Checklist for Preschool Children
C-TRF	Care Taker Report Form
DIS	Difficulty initiating sleep
DMS	Difficulty maintaining sleep
FIQ	Full scale IQ score
PIQ	Performance IQ
UTSA	Unwilling to sleep alone
VIQ	Verbal IQ

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Methods

The current study is a baseline data analysis of a cohort of 1656 kindergarten children, accounting for 24.3% of all children aged 4-6 years in Jintan city, Jiangsu province, China. Detailed information on the Jintan Cohort Profile, including subjects, recruitment, and procedures, has been reported elsewhere.[21] The current study used a sample of 1385 children (620 girls, 765 boys) for whom complete sleep information and cognitive assessment were available, with a mean (SD) age of 5.72 (0.42) years. Child and family characteristics of the sample are summarized in **Table I** (available at www.jpeds.com). Institutional Review Board approval was obtained from the University of Pennsylvania and the ethical committee for research at Jintan Hospital.

Sleep problems were assessed with Chinese versions of the Achenbach System of Empirically Based Assessment and CBCL,[22] completed by the child's parent, and the Achenbach System of Empirically Based Assessment Care Taker Report Form (C-TRF), completed by the child's teacher. The CBCL contains 6 sleep items and 2 fatigue items. Parents answered questions about their child's experiences with the following: unwilling to sleep alone (UTSA); difficulty initiating sleep (DIS); having nightmares; resisting going to bed at night (sleep resistance); sleeping less than most children (sleep less); talking or crying out in sleep (sleep talking/crying); difficulty maintaining sleep (DMS); being overtired (tiredness); and being under active, slow moving, or lacking energy (lack of energy). The C-TRF contains 2 fatigue items: being overtired (tiredness) and being under active, slow moving, or lacking energy (lack of energy). Items were rated for current frequency or frequency within the past 2 months (0 = never, 1 = sometimes, 2 = often). The CBCL and C-TRF have demonstrated satisfactory psychometric properties in the assessment of behavioral and emotional problems in Chinese children[21] and has been used to assess sleep problems in Chinese and other ethnic populations of children.[8,23]

Children's cognitive performance was assessed by the Chinese version and norms of the Wechsler Preschool and Primary Scale of Intelligence–Revised. The test was constructed by Wechsler (1967) to assess the intelligence of children ages 3-7 years. The Wechsler Preschool and Primary Scale of Intelligence was standardized in China in 1988[19,20] and has demonstrated good reliability in Chinese children.[19,20,24,25] The Wechsler Preschool and Primary Scale of Intelligence consists of 10 subtests; 5 of these comprise the verbal IQ (VIQ: information, comprehension, arithmetic, vocabulary, and similarities) and 5 the performance IQ (PIQ: object assembly, geometric design, block design, mazes, and picture completion). The VIQ and PIQ are combined to yield a full scale IQ score (FIQ), which is defined as the average of all cognitive abilities and is widely recognized as a good measure of general intelligence. Further detailed descriptions of the setting and procedures of the IQ testing can be found in Liu and Lynn.[26]

Sociodemographic information included child's sex, age, siblings (yes/no), parent education, parent occupation (ie, occupation held for the longest period of time), and residence (ie, city, suburb, or rural). Parent occupation was categorized into unemployed, working class, and professional.

Statistical Analysis

Characteristics of the study sample were summarized by descriptive statistics such as mean, SD, and percentage. A series of multivariate ANOVA were performed to examine the association between each sleep problem and mean IQ scores. General linear models were performed to examine the adjusted associations between individual sleep problems and VIQ, PIQ, and FIQ while controlling for child age, child sex, residence, parent education, parent occupation, and presence of siblings. These demographic variables were selected on the basis of literature[7,8,11] and/or our preliminary analyses indicating these variables were associated with either or both IQ and child sleep problems. A P value of <.05 was considered significant. Data were analyzed using SPSS, v. 17 (SPSS Inc, Chicago, Illinois).

Results

The prevalence of sleep problems and fatigue are detailed in **Table II**. Sleep problems endorsed as "sometimes" or "often" were prevalent, ranging from 8.9% for DMS to 70.5% for unwillingness to sleep alone. Other sleep problems occurring "sometimes" or "often" included DIS (39.4%), having nightmares (31.6%), sleep talking (28%), sleep less (24.7%), and resisting going to bed at night (23.4%). Fatigue was assessed through ratings of overtiredness and lack of energy. Parents reported overtiredness occurring "sometimes" or "often" in 29.6% of children and lack of energy occurred in 12.6%. Teacher reported fatigue was less prevalent, with 4.7% of children being overtired and 17.2% lack of energy. There were no significant differences between boys and girls in any of the sleep and fatigue items (all *P* values >.05).

The mean (SD) IQ test scores for the 1331 children (96.10%) who had available IQ information are given in **Table III**. In general, boys scored significantly higher than girls in VIQ (2.2 points), PIQ (2.0 points), and FIQ (2.4 points) (all *P* values <.05).

To examine the association between sleep problems and fatigue and children's VIQ, PIQ, and FIQ, multivariate ANOVA was conducted (**Table IV**; available at www.jpeds.com). All sleep problems with the exception of unwillingness to sleep alone, DIS, and sleep less were recoded into binary categories of yes/no (instead of never/sometimes/often) because those items were infrequently endorsed as occurring "often" (<5%).

Significant differences in VIQ were found between children with and without sleep problems, with the exception of DIS, sleep talking, and sleep less as reported by parents and overtiredness as reported by teachers. Significant

Table II. Sleep problems and fatigue in Chinese preschool children

	N	n (%)		
		No	Sometimes	Often
UTSA	1205	355 (29.5)	438 (36.3)	412 (34.2)
DIS	1205	730 (60.6)	360 (29.9)	115 (9.5)
Nightmares	1208	826 (68.4)	361 (29.9)	21 (1.7)
Sleep resistance	1207	925 (76.6)	246 (20.4)	36 (3.0)
Sleep less	1181	889 (75.3)	221 (18.7)	71 (6.0)
Sleep talking/crying	1208	870 (72.0)	310 (25.7)	28 (2.3)
DMS	1206	1099 (91.1)	104 (8.6)	3 (0.2)
PR tiredness	1206	849 (70.4)	335 (27.8)	22 (1.8)
PR lack of energy	1202	1050 (87.4)	139 (11.6)	13 (1.1)
TR tiredness	1207	1150 (95.3)	51 (4.2)	6 (0.5)
TR lack of energy	1206	998 (82.8)	191 (15.8)	17 (1.4)

PR, parent reported; *TR*, teacher reported.

differences in PIQ were found among children having problems with sleep less and lack of energy, as reported by both parents and teachers. Compared with children who did not have such sleep problems, significant differences in FIQ were found for children with parent-reported unwillingness to sleep alone, sleep less, DMS, nightmares, tiredness, and lack of energy, as well as teacher-reported lack of energy. Illustratively, children without sleep problems had higher FIQ than children who did, with the exception of children who were reported to sleep less.

Multivariate Analysis

To examine the independent associations between sleep problems/fatigue and children's IQ, general linear models were conducted to control for the potential confounding effects of child and family characteristics. Most sleep problems and fatigue items, including unwillingness to sleep alone, nightmares, sleep resistance, sleep talking, DMS, daytime tiredness, lack of energy as reported by parents, and lack of energy as reported by teachers, were significantly associated with reduced VIQ. The mean VIQ in children who were often UTSA was about 2 points lower than that of children who did not have the sleep problem. Average VIQ was 2-5 points lower in children who had other sleep problems than those who did not (**Figure**). Only nightmares and lack of energy as reported by both parents and teachers was associated with reduced PIQ; average PIQ was up to 6 points lower in children whose parents or teachers reported them as lack of energy, compared with children not reported as lack of energy.

Most sleep problems were also associated with reduced FIQ, including nightmares, sleep resistance, sleep talking, DMS, tiredness, and lack of energy as reported by parents, and lack of energy as reported by teachers. Adjusted mean differences ranged from 1.9 for nightmares to 6.1 for lack of energy as reported by teachers (**Figure**).

Discussion

This study examined the prevalence of sleep problems and fatigue, and their associations with cognitive performance in a large community sample of Chinese children aged 4-6 years. Our major findings include: (1) sleep problems were prevalent, ranging from 8.9% for DMS to 70.5% for UTSA; (2) fatigue was prevalent, with 29.6% of children reported to be overtired and 12.6% lack of energy; (3) children with DMS, sleep talking, sleep resistance, or nightmares scored 2-3 points lower in full IQ than children without sleep problems; and (4) children reported to have fatigue scored 3-6 points lower in full IQ than those children without fatigue, after adjusting for child and family sociodemographic variables. Furthermore, we observed that overall, our sample showed a significant increase in IQ scores compared with data from 1984.[19,24] Such a finding is consistent with the "Flynn Effect," a phenomenon of substantial increase in IQ scores over time measured in many parts of the world.[27,28]

The first objective of this study was to investigate the prevalence of sleep problems and fatigue in Chinese kindergarten children. Our analyses showed that sleep problems previously reported in studies of Chinese and Western school-aged children[1,7-9,29] were common in this sample of preschool children. DMS (8.9%) was the least prevalent problem in our sample; although a similar DMS prevalence was reported in Swedish preschoolers (8.4%),[30] DMS has been reported much more frequently for preschoolers in the United States[1] and Finland.[31] Overall, however, our findings suggest that Chinese preschoolers do not have a lower prevalence of sleep problems than their Western counterparts. Indeed, problems such as nightmares and sleep-talking/crying were consistently reported more frequently in our Chinese sample than in same-age children from Western countries (eg, 31.6% vs. 3%-8% for nightmares).[1,30,31] DIS (39.4%) was common within our Chinese sample. Although this finding was once again similar to reports from Sweden (39.5%),[30] this was much higher than findings in the United States and Finland (10%-20%).[1,31] Unwillingness to sleep alone (70.5%) was particularly problematic in this sample. This problem may reflect Chinese cultural practices of bed sharing rather than a true clinical sleep disturbance, as studies have shown that regular bed sharing in Chinese school-aged children is very common.[11]

Table III. Cognitive performance in Chinese preschool children

IQ	Total		Girls		Boys		t (*P*)
	n	M (SD)	n	M (SD)	n	M (SD)	
Verbal	1331	103.95 (14.84)	602	102.74 (14.80)	729	104.96 (14.81)	2.72 (.007)
Performance	1331	104.06 (15.07)	602	102.96 (15.12)	729	104.96 (14.99)	2.14 (.016)
Full	1331	104.19 (14.38)	602	102.89 (14.50)	729	105.26 (14.21)	2.99 (.003)

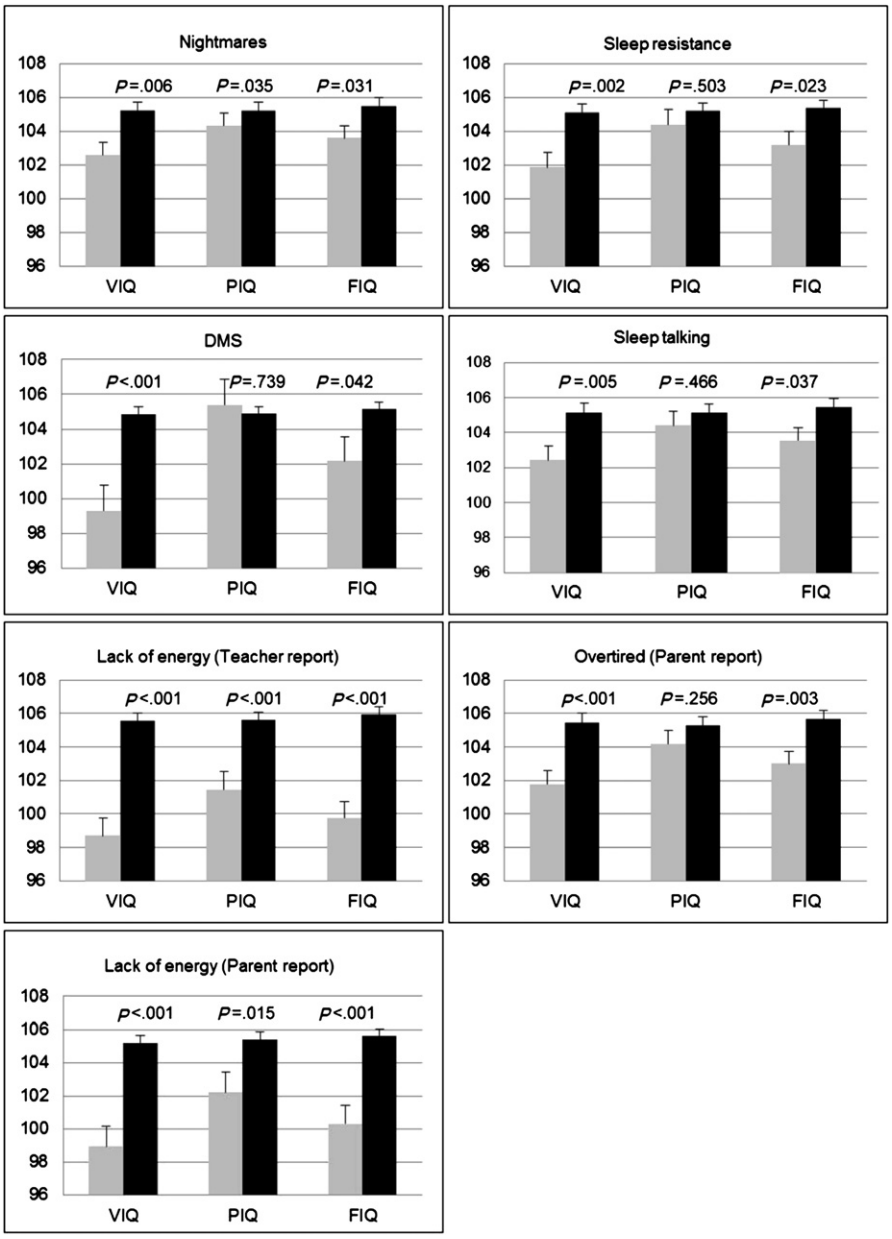

Figure. Adjusted means (SE) of cognitive performance between children with and without sleep problems/fatigue, adjusted for age, sex, residence, sibling, paternal and maternal education, and occupation.

Fatigue is an overwhelming sense of tiredness, lack of energy, and feeling of exhaustion. Studies have shown that chronic fatigue is prevalent in school-aged children and is associated with attention and memory problems,[32] but previous work on fatigue in young children has focused primarily on children with chronic diseases.[33,34] To our knowledge, no community-based study has examined fatigue in kindergarten-aged children. According to parental reports, fatigue in our sample was not uncommon: about 30% of kindergarten children felt overtired and 17% lacked energy during the day. Teacher reports indicated 11.2% and 4.7% of children were lacking energy and overtired during the day at school, respectively. Differences in parent and teacher reports of fatigue did exist. Home settings are less social than school settings, particularly among single children who do not have siblings with whom to play and interact. It may be that parents are simply observing less activity in the home setting than teachers are observing in the child in the school setting, and this in turn is being interpreted as fatigue by parents. It is also possible that this finding reflects the fact that parents typically observe children later in the day (eg, after they have returned from school) when fatigue has compounded.

Our second objective was to examine the association between sleep, fatigue, and cognitive performance, as measured

by standardized IQ testing. Results indicate that most sleep problems and fatigue were associated with reduced VIQ and/or PIQ, as supported by significant literature linking sleep and neurocognitive functioning. However, VIQ was more strongly associated with many of the sleep disturbance items than PIQ; the latter was only associated with lack of energy (as measured by parents and teachers). This may reflect the fact that types of sleep disturbance differentially affect various domains of neurocognition rather than necessarily producing global deficits. Because PIQ is heavily affected by motor skills and performance speed, it is logical that these subtests would be greatly impacted by low energy. A complete dissection of the neural underpinnings of sleep and cognition is beyond the scope of this article (see Killgore for review[15]); however, in brief, healthy sleep directly supports neurocognition through increased synaptic changes, neurotransmitter activation, and neuronal firing, which in turn facilitates abilities such as memory consolidation, modulation, and regulation; learning, visual processing, and more. Functional imaging has also identified the prefrontal cortex, which is responsible for complex higher-order cognition, attention, and arousal, as being particularly vulnerable to sleep loss.[16]

There are several possible mechanisms underscoring the connection between sleep, fatigue, and IQ in children. It may be that the children in our sample who had poor sleep and excess fatigue performed more poorly on IQ testing due to sleep-related deficits in memory, attention, and alertness. Sleep quality may indirectly affect cognition and IQ through psychosocial factors, such as eagerness, which may influence test performance.[17] Differential effects of sleep disturbance on children's cognition have been observed across racial and socioeconomic groups,[35] raising questions about environmental contributors to the sleep-cognition relationship. Of note, Mayes et al found that parent reports of sleep problems and data from polysomnography did not predict math and reading test scores in children,[18] suggesting that relationships between subjective reports of sleep and objective cognitive performance may be accounted for by common, non-sleep-related factors, such as behavior, mood, and parenting style. Therefore, it is important not to limit discussion of cognition and sleep to biologic contexts and to include cultural, environmental, and other non-biologic constructs of potential relevance. Whether non-biologic factors like culture or familial factors contributed to our findings cannot be extrapolated but is warranted for further study.

Although our findings help expand the literature on sleep and fatigue and cognition in young children, there are some limitations of note. First, because of this study's cross-sectional design, no causal-relationship can be concluded. Second, sleep problems were derived from a parent-completed behavior checklist and not through objective sleep measures like polysomnography. A lack of objective data on sleep duration was also a challenge, as many parents reported that their child slept less, but without a sibling with whom to compare, it is not entirely clear what is meant by "less." Finally, the association between sleep problems, fatigue, and IQ may be mediated by sleep duration and sleep quality. Sleep breathing problems are prevalent in young children, which may also link sleep, fatigue, and cognitive performance. However, we did not collect these data.

Despite these limitations, our study shows that sleep problems and fatigue are prevalent in Chinese kindergarten children and demonstrates the association between sleep, fatigue, and impaired cognitive performance in a large community sample of young children. Nevertheless, children of this cohort are now entering teenage years and we are currently conducting the second wave of behavior assessment. Data collection is ongoing and longitudinal analyses will be made in the near future that will provide information for determining whether robust causal relationships exist and allow us to address some of the limitations noted above. Such data will also help clarify whether the statistically significant, yet not clinically significant, differences we detected in cognitive outcomes of sleep disturbed and non-sleep disturbed children have any future implications. Our current and future findings may have important implications for early screening of and intervention for sleep problems and fatigue to improve child cognitive development and academic performance. ■

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Table I. Sample characteristics

	N	%
Sex		
Male	765	55.2
Female	620	44.8
Age, mo		
M (SD)	1201	68.85 (4.99)
Range		50.01-89.82
Residence		
City	961	73.8
Suburban	188	14.4
Rural	154	11.8
Father education		
<Middle school	42	3.2
Middle school	461	35.4
High school	420	32.2
College or higher	381	29.2
Father occupation		
Unemployment	52	4.1
Physical worker	718	56.9
Professional	492	39.0
Mother education		
<Middle school	75	5.7
Middle school	582	54.6
High school	384	29.4
College or higher	264	20.2
Mother occupation		
Unemployment	338	26.6
Physical worker	554	43.6
Professional	379	29.8
Marital status of parents		
Married	1157	95.6
Divorced	53	4.4
Number of siblings		
No	970	81.5
1 or more	220	18.5

Table IV. Sleep problems and cognitive performance in Chinese preschool children

	VIQ				PIQ				FIQ			
	No	Sometimes	Often	F (*P*)	No	Sometimes	Often	F (*P*)	No	Sometimes	Often	F (*P*)
UTSA												
n	352	434	410	2.93	352	434	410	1.97	352	434	410	3.06
M	103.43	105.57	103.38	(.054)	103.02	105.15	104.32	(.140)	103.27	105.73	104.04	(.047)
SD	15.41	14.88	14.30		16.47	14.24	14.60		15.46	14.02	13.78	
DIS												
n	727	357	112	0.05	727	357	112	1.16	727	357	112	0.67
M	104.08	104.36	104.00	(.953)	103.70	105.17	104.29	(.313)	104.04	105.11	104.30	(.513)
SD	15.03	14.64	15.19		15.54	14.22	13.77		14.70	14.03	13.78	
Sleep less												
n	882	221	69	2.47	882	221	69	3.72	882	221	69	3.09
M	103.74	104.34	107.83	(.087)	103.56	106.45	105.93	(.025)	103.82	105.69	107.39	(.046)
SD	15.10	13.44	16.46		15.00	14.63	16.40		14.42	13.67	16.50	
Nightmares*												
n	820	379		3.03	820	379		1.10	820	379		2.35
M	105.04	102.25		(.003)	104.57	103.54		(.272)	105.07	102.97		(.019)
SD	15.48	13.38			15.42	14.23			15.04	12.85		
Sleep resistance*												
n	919	279		3.16	919	279		0.32	919	279		2.06
M	104.90	101.69		(.002)	104.31	103.99		(.752)	104.87	102.84		(.039)
SD	15.04	14.20			15.36	14.05			14.59	13.76		
Sleep talking*												
n	865	334		1.75	865	334		0.37	865	334		0.78
M	104.62	102.94		(.800)	104.14	104.50		(.711)	104.61	103.89		(.436)
SD	15.14	14.19			15.50	13.85			14.86	13.20		
DMS*												
n	1090	107		4.19	1090	107		0.20	1090	107		2.59
M	104.71	98.43		(<.001)	104.27	103.96		(.839)	104.74	100.97		(.010)
SD	14.83	14.44			15.03	15.40			14.36	14.57		
PR-tiredness*												
n	843	354		4.04	843	354		1.23	843	354		3.05
M	105.28	101.49		(<.001)	104.61	103.44		(.219)	105.24	102.47		(.002)
SD	14.94	14.52			15.29	14.47			14.60	13.81		
PR-lack of energy*												
n	1043	150		5.13	1043	150		2.66	1043	150		
M	105.00	98.39		(<.001)	104.75	101.27		(.008)	105.16	99.57		4.47
SD	14.89	13.84			15.04	14.68			14.40	13.60		(<.001)
TR-tiredness*												
n	1141	57		1.60	1141	57		1.51	1141	57		1.77
M	104.29	101.07		(.111)	104.39	101.30		(.130)	104.56	101.11		(.077)
SD	14.85	15.59			15.01	15.83			14.36	15.37		
TR-lack of energy*												
n	990	207		8.26	990	207		5.75	990	207		8.13
M	105.76	96.61		(<.001)	105.40	98.87		(<.001)	105.94	97.22		(<.001)
SD	14.46	14.67			14.42	16.79			13.80	15.11		

F, F statistic.
*"Often" and "Sometimes" were combined due to "Often" less than 5%.