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Association between children's sleep habits and problematic behaviors at age 5

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Abstract

Background: Night-shift lifestyles affect children as well as adults, and are associated with sleep and behavioral problems among children. This study aimed to investigate associations among sleep habits, individual/environmental factors, and problematic behaviors in children at age 5 years.

Methods: Data for sleep habits, individual/environmental factors and problematic behaviors for 8,689 5-year-old children were collected from health checkup records. Problematic behaviors investigated were anxious behavior (being afraid, difficulty being separated from the mother), developmental behavior (violence, restlessness, rebellious behavior, restrictive diet, stereotypic play), personal habits (thumb-sucking, nail-biting, tic, masturbation), and excretory problems. The relationships between sleep habits (bedtime, sleep duration) and the presence of these behaviors were analyzed. Individual/environmental factors that affected problematic behaviors were statistically identified using a tree form model.

Results: Late bedtime and short sleep duration showed significant adverse effects on children's problematic behaviors (odds ratio [OR]: 1.07, 95% confidence interval [CI]: 1.03–1.11 and: OR 0.92, 95% CI: 0.87–0.97, respectively). Long television watching time, abnormality at birth, and lack of father's support also showed significant adverse effects on problematic behaviors (OR 2.34, 95% CI: 1.87–2.94), and significantly affected late bedtime and short sleep duration.

Conclusions: There were significant associations among sleep habits, individual/environmental factors, and problematic behaviors in 5-year-old children. Improving children's sleep habits, reducing the duration of television watching, and improving support from father may reduce problematic behaviors.

Keywords: Sleep habits、Individual/environmental factors、Problematic behaviors

Introduction

Recent research suggests children's sleep habits are characterized by late bedtimes and short sleep time; these habits have been observed in preschool children as well as in adolescents.[1] The Japanese Children's Health Association reported that, the percentage of children with late bedtime (sleep after 10 pm) increased in the last 30 years in children of all ages.[2] Specifically, over this period, late bedtime increased from 25% to 30% among children aged 18 month, from 22% to 31% in those aged 3 year, and from 10% to 25% in those aged 5–6 year.[2] Furthermore, children's sleep duration has become shorter over the last five decades, and is now more than 1 hour shorter among preschool children.[3] These changes in children's sleep habits may have adverse effects on their physical and mental conditions. Longitudinal studies by Bonuck et al. showed that short sleep duration in early childhood increased the risk for developing obesity at age 15 years.[4] In addition, a significant relationship was found between sleep habits (e.g., short sleep duration of <10 hours, nocturnal awaking three or more times) in children aged 18 months with typical development and emotional problems at age 5 year.[5] These findings indicate that assessment of sleep habits in preschool children is important to prevent future problematic health conditions.

Children's sleep habits are affected by various factors, including individual characteristics, family structure, and environmental factors. Several reports have investigated abnormal sleep habits or sleep disorders in children with developmental disorders.[6] For example, a survey of the sleep habits of 372 school children using the Children's Sleep Habits Questionnaire found that bedtime resistance, sleep onset delay, and daytime sleepiness worsened with increasing age in children with developmental disorders.[7] Another study reported a high frequency (67%) of sleep problems (e.g., late bedtime and short sleep duration) in children with attention-deficit hyperactivity disorder (ADHD) and autism spectrum disorder (ASD) aged 6–12 year.[8] Sleep deprivation at age 2 years was also found to be significantly related to attention deficit or aggressive behaviors at age 8 year.[9] Additionally, many lifestyle habits or environment factors are associated with poor sleep habits. For example, the use of media equipment before bedtime had a significant relationship with shortened sleep duration in children.[10] Single parent families have also been associated with late bedtime among children.[11] Preschool children with late or irregular risers/sleepers showed significant higher problematic internalizing and externalizing symptoms.[12] Moreover, exposure to passive smoking was related to sleep disorders in children with asthma.[13] Groner et al. reported that secondhand smoke exposure has been linked to a greater risk of sleep-disordered breathing in healthy toddlers aged 2 to 5 years.[14]

These findings show that individual and environmental factors play key roles in children's sleep habit. However, few studies have investigated the associations among sleep habits, problematic behaviors, and individual/environmental factors in preschool children with typical development.[15] Therefore, these study aimed to investigate these associations among preschool children at age 5 years using health check records for a large number of children.

Methods

Data source

In Japan, Maternal and Child Health Law requires children to have health checks at the ages of 18 months and 3 year. The main purpose of these infant health checks is to monitor healthy growth and support parental concerns about infants' growth and development. The cost of these health checks is covered by the government. Independently of local government budgeting, municipalities also implement health checks for children at ages 3–4 months and 9–10 months.

The Pediatric Association of Fukuoka District also runs its own infant health check system. This system covers health checks at the ages of 1, 3–4, 9–10, 12, and 18 months and 2, 3, 4, 5, and 6 years. Parents pay a fee to have their children take part in these health checks.

In the present study, health check data for 8,689 5-year-old preschool children were obtained from the Pediatric Association of Fukuoka District System. The preschool children included in this sample were born in 2009 or 2010, and underwent their 5-year-old health check in 2014 or 2015 at primary pediatric clinics. The population of Fukuoka city in 2014 (2015) was 1.4 million (1.4 million), of which 12,442 (12,232) were 5-year-old children. The participation rate for the 5-year health check was estimated at 36.5%.

Health checkup data

Health checkup data for preschool children included parents' descriptions of individual factors, environmental information, sleep records, developmental records, caregivers' concern/worries about children's behaviors, and medical evaluation by primary care physicians. Information for individual factors included: the child's sex, birth order, birth weight, gestational weeks, and birth abnormalities. Environmental information included: parental age, parents' smoking habits in pregnancy, parents' current smoking habits, presence of someone to consult for childcare, father's cooperation in childcare, and television watching time per day. Sleep records included recent average bedtime and waking time. Caregivers' concerns for children's behaviors included anxious behavior

(e.g., being afraid, having difficulty separated from the mother), developmental behavior (e.g., violence, restlessness, rebellious behavior, restrictive diet, stereotypic play), personal habits (e.g., thumb-sucking, nail-biting, tic, masturbation), and excretory problems (e.g., enuresis, constipation, encopresis). When the caregiver checked one or more of those symptoms/problems/habits on the health checkup form, it indicated that child had possible problematic behaviors about which the caregiver was concerned. Other information collected included the child's vaccination history, development history (head control when sitting, sitting position, started walking, speech), current development (color distinction, visual and auditory acuity), accident history (injury, burns, accidental ingestion), height, and weight.

Analysis

Data analysis aimed to examine the effect of bedtime and sleep duration on problematic behaviors, defined as a binary outcome. Individual sleep duration was calculated with each bedtime and wake-up time. Five individual factors (sex, birth order, birth weight, gestational age, and abnormality at birth) and nine environmental factors (mothers'/fathers' age, mothers'/fathers' smoking habits in pregnancy, mothers'/fathers' current smoking habits, presence of someone to consult for childcare, fathers' cooperation in childcare, and television watching time per day) were considered as potential confounding variables. Fourteen confounding variables were asymmetrically combined and five homogeneous groups were constructed using a classification and regression tree (CART) model. Logistic regression was then used to estimate odds ratios (OR) for bedtime and sleep duration on problematic behaviors after adjusting for confounding variables as defined in the CART model. We excluded data for 116 of the 8,689 children because of insufficient descriptions.

Ethics

Informed consent requirement in this study was waived due to the retrospective observational study, carried out by the opt-out method at the institution's website. This study was approved by the Ethical Committee of Kurume University of Medicine (#19292).

Results

Sleep habits (average bedtime and sleep duration)

Figure 1 shows the distribution of bedtime and sleep duration for 8,573 5-year-old preschool children. The average bedtime was 21:20 and average sleep duration was 9.9

hours.

Overview of problematic behaviors at age 5 year

Table 1 presents an overview of the frequency of problematic behaviors at age 5 year. In total, 22% of caregivers marked one problematic behavior on the health check-up record, and 7% marked more than one problematic behavior. Overall, 71% of children showed no behavioral problems; 10.1% of children had nail-biting and 4.8% had thumb-sucking as personal habits and 6.9% had restlessness.

Overview of individual and environmental factors

Table 2 shows the numbers and frequencies of individual and environmental factors. There were no sex-based differences in individual factors, and 4,325 children (51.0%) were first-born. Low birth weight (<2,500 g) was reported for 809 (9.7%) children, and 485 (6.4%) children were premature infants (<37 weeks). In addition, 549 (6.6%) children were born with a birth abnormality, such as neonatal asphyxia, jaundice, congenital heart disease, or respiratory disorder.

In terms of environmental factors, 2,839 (28.9%) mothers were aged ≥35 year. Smoking during pregnancy was reported for 44.7% of fathers and current smoking for 40.0% of fathers. However, lower rates of mothers smoked during pregnancy (4.0%) and currently (9.9%) compared with fathers. In addition, 204 (2.4%) caregivers reported they had no one to consult regarding child-rearing, and 424 (5.3%) caregivers had no cooperation from the father during child-rearing. Although about half of the children (48.7%) watched television for <2 hours per day, the remaining children (51.3%) watched television for >2 hours per day.

Relationship between sleep habits (bedtime, sleep duration) and problematic behaviors

There were significant relationships between bedtime and sleep duration and the presence of problematic behaviors. There were more problem behaviors among children with late bedtime (OR 1.07, 95% confidence interval CI: 1.03–1.11) and short sleep duration (OR 0.92, 95% CI: 0.87–0.97) than among children without those factors (Table 3).

Relationship between problematic behaviors and individual/environmental factors

The CART model showed that watching television for >2 hours per day was significantly associated with the presence of problematic behaviors (Figure 2). When the model considered children with <2 hours television watching/day and non-first birth

order (Group E) as the reference, the maximum OR was obtained for children with >2 hours television watching/day and birth abnormalities (Group A) (OR 2.34, 95% CI: 1.87–2.94) (Table 3). Children with >2 hours television watching/day, no birth abnormalities, and that lacked the father's support (Group B) showed an OR of 2.15 (95% CI: 1.75–2.65). Group C (children with >2 hours television watching/day, no birth abnormalities, and father's support) and Group D (children with <2 hours television watching/day and first-birth order) also showed significant OR: 1.43 (95% CI: 1.26–1.63) and 1.38 (95% CI: 1.20–1.59), respectively (Table 3).

Relationships between television watching, abnormality at birth, lack of father's support and sleep habits

The CART model revealed that watching television, abnormality at birth, and lack of father's support were important factors that affected children's problematic behaviors. Therefore, we checked whether these three factors affected sleep habits (bedtime and sleep duration). Tables 4 and 5 show the means and standard deviations for bedtime and sleep duration in each group as classified in Figure 2.

Although the average bedtime for the reference group (Group E: children who were with <2 hours television watching/day and non-first birth order) was 21:13, the average bedtime for Group A (children with >2 hours television watching and birth abnormalities) was 21:32 (Table 4). The difference between the groups was significant, which suggested that longer television watching/day and birth abnormalities significantly affected a later bedtime. Similarly, the average bedtimes for Group B (children with >2 hours television watching/day, no birth abnormalities, and lack of father's support) and Group C (children with >2 hours television watching/day, no birth abnormalities, and father's support) were significantly later than that of Group E (reference) (Table 4). However, the average sleep duration for Groups A, B and C was significantly shorter at 9.8 hours, 9.7 hours, and 9.9 hours respectively, compared with the sleep duration of 10.0 hours in Group E (reference) (Table 5).

Discussion

We analyzed associations among sleep habits, individual/environmental factors, and problematic behaviors using health checkup data for over 8,000 5-year-old preschool children. A late bedtime and short sleep duration were strongly associated with problematic behaviors. Moreover, environmental factors such as longer television watching time, birth abnormalities, and lack of father's support also had strong relationships with problematic behaviors. These environmental factors had a strong

influence on children's sleep habits.

Regarding the appropriate bedtime and sleep duration for children aged 5 year, the American Society of Sleep Medicine recommends sleep duration of 10–13 hours for healthy preschool 3–5 years.[16] Parsons et al. conducted a cross-sectional study involving 359 preschool children aged 3–5 year, and reported that about 65% went to bed before 9 pm and the average total sleep duration was 11.2 hours.[17] In our study, average bedtime and sleep duration for 5-year-old children were 21:20 and 9.9 hours, respectively. This indicated Japanese preschool children had a later bedtime and shorter sleep duration, compared with children in Western countries. A possible reason for these sleep habits in Japanese children may be the cultural custom of co-sleeping. For example, more than 80% of preschool children and their parents share a bedroom in Japan, whereas the prevalence of co-sleeping in Western countries is reported to be 20%–40%.[18-20] Co-sleeping is strongly associated with negative sleep qualities such as night waking, sleep anxiety, and bedtime resistance, which supports a link between the high prevalence of co-sleeping and later bedtime, and shorter duration of sleep among children in Japan.[19-20]

Our study revealed that children with late bedtime and short sleep duration showed significant adverse effects in terms of the presence of problematic behaviors including anxiety, developmental behaviors, and personal habits. Several studies have reported associations between short sleep duration and physical and behavioral problems.[21] Sakamoto et al. reported an association between shorter sleep duration and increased risk for obesity and behavioral problems such as restless behavior, fidgety behavior, and poor concentration in school.[22] Doi et al. reported that children sleeping at irregular times showed higher behavior problems, especially hyperactive/inattention and peer relationship problems.[23] The causal relationship between late bedtime and problematic behaviors may reflect bedtime resistance or sleep onset delay in children who developmentally have restlessness or hyperactivity, which are often observed in children with ADHD or ASD. Neuroimaging and electrical encephalogram studies revealed deficits in frontal neuronal processing for attention or worse parietal white matter integrity caused by the effects of short sleep duration; however, the neural processes involved in behavior related to short sleep duration are poorly understood.[24-25]

On the other hand, some literatures revealed that short sleep duration is not always of unfavorable effects on brain functions with preferable neurocognitive measurements in adults.[26-27]

Our results suggested that individual/environment factors also influenced the presence of problematic behaviors. Our CART analysis indicated that time watching television (>2 hours) showed the most significant association with problematic behaviors.

CART analysis is a simple but powerful analytic tool that helps determine the most important variables in a particular dataset. Watching television is a growing concern as excessive watching has harmful effects for children's academic and behavioral development. Tremblay et al. conducted a meta-analysis of 232 studies on television watching time among children aged 5–17 years and reported that watching television >2 hours per day was associated with poor physical condition, decreased physical fitness, and declines in self-esteem, social behavior, and academic performance.[28] Takeuchi et al. reported that long-term television watching had a bad influence on developmental changes and linguistic intelligence in the higher cognitive functional area, including the frontal pole of the brain.[29] A possible explanation for this association is that parents may use television as a means of coping with children's hyperactive behavior. Moreover, such television exposure was strongest among children in low socioeconomic families and those whose parents displayed less than optimal mental health. Our CART analysis showed that birth abnormalities and the lack of father's support had the second and third most significant associations with problematic behaviors. Neonatal asphyxia, which was seen in 6.4% of children in our study, has been reported to be a risk factor for developmental disorders.[30] Furthermore, positive parental involvement in child-rearing was inversely associated with low child maladaptive behavior.[31] To reduce children's problematic behaviors, caregivers and health providers should be aware of these associations.

Negative environmental factors (excessive television watching time, presence of birth abnormalities, and lack of father's support) also had significant adverse effects on late bedtime and short sleep duration in our study. Several previous reports have described these associations. For example, McDonald et al. reported that watching television for >1 hour after 6:30 pm was related to late bedtime among 1,702 children (average age of 15.8 months) using a modified version of a sleep questionnaire.[32] Nevarez et al. also reported a significant association between television watching time and shortened sleep duration in early childhood.[33] Another study found that children with a television in their bedroom had shorter sleep duration than children with no television in their bedroom.[34]

In terms of birth abnormalities, birth trauma often causes circadian rhythm disorders in children with severe motor and intellectual disabilities, resulting in sleep disorders.[35] Mothers are also reported to feel stress more strongly than fathers when their infant has a sleep disorder.[36] The lack of father's support may become a contributing factor for childcare stress among mothers. Kato et al. conducted a multiple logistic regression analysis using a questionnaire survey of 404 caregivers of children aged 5–6 years.[37] They reported a significant association between the child's irregular sleep rhythm and

the caregiver's stress. Key findings in our study were that average bedtime and average sleep duration were worse when children had both longer television watching time per day and lack of father's support, compared with children that only had longer television watching/day. This may indicate that sleep habits may become worse as the number of negative environmental factors increases. To improve children's sleep habits, it is important to restrict television watching time and obtain the father's support. Improvement of both sleep habits and environmental factors (reducing television watching time and increasing father's support) may lead to improvement in children's problematic behaviors.

There were several limitations in our study. Assessment of children's problematic behaviors was based on parents' subjective observation and not an objective observation by a pediatrician or other developmental examination. Similarly, the assessment of sleep habits was based on analysis of sleep bedtime and duration. Therefore, comprehensive sleep habits (including midway awakening, presence of naps, and co-sleeping) should be assessed in further studies. Another limitation was that the definition of children's problematic behaviors in this study included one or more specific categories, such as anxious behavior, developmental behavior, personal habits, and excretory problems. Those behaviors may be affected more or less strongly by sleep habits or environmental factors; therefore, the analysis of associations should be performed separately for each category of behavior in further research. In addition, we had no information regarding the annual income or academic background of the children's parent, or their family structure. Furthermore, though longer television watching time showed the most significant association with problematic behaviors and sleep habits, other media equipment such as tablet devices, smartphones, portable games and home videogames should be considered. These variables may also affect sleep habits and behavioral development among children.

In conclusion, sleep habits along with individual and environmental factors were significantly related to problematic behaviors among preschool children aged 5 year. Promotion of better sleep habits among children and improvement in their living environment and individual factors may reduce problematic behaviors.

Figure legends

Figure 1

Distribution of bedtime and sleep duration in 8,573 5-year-old preschool children. The average bedtime and sleep duration were 21:20 (vertical line) and 9.9 hours (horizontal line), respectively.

Figure 2

Classification and regression tree analysis of problematic behaviors.

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Author contributions

MS, SN, KS, and MK participated in the design of this study and MS and SN compiled the manuscript. GS, RI, and KY extracted all 8,689 health checkup data from the health records, and inputted them into data format sheets. HO and TK conducted the statistical analyses. TM, ZY and YY supervised the preparation of the manuscript.

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Table 1. Overview of problematic behaviors at 5 years old (N=8,573)

	number	%
Anxious behavior		
being afraid	139	1.6
difficulty being separated from one's mother	61	0.7
Developmental behavior		
being violent	90	1.0
restlessness	590	6.9
rebellious behavior	315	3.7
restrictive diet	239	2.8
stereotypic play	63	0.7
Personal habits		
thumb-sucking	411	4.8
nail-biting	866	10.1
tic	65	0.8
masturbation	185	2.2
Excretory disorder	541	6.3
enuresis, constipation, and encopresis		
No problematic behavior	6,117	71.4

Table 2. Overview of individual and environmental factors

			number	%
Individual factor	Sex	Boys	4298	50.7
		Girls	4182	49.3
	Birth order	First child	4325	51.0
		Second child	4157	49.0
	Birth weight, grams	<2500	809	9.7
		≥2500	7540	90.3
	Gestational age, weeks	<37	485	6.4
		≥37	7097	93.6
	Abnormality at birth	No	7806	93.4
		Yes	549	6.6
Environmental factors	Father's age, years	<35	4503	58.4
		≥35	3208	41.6
	Mother's age, years	<35	5859	71.1
		≥35	2387	28.9
	Father smoking during pregnancy	No	4495	55.3
		Yes	3640	44.7
	Mother smoking during pregnancy	No	8129	96.0
		Yes	338	4.0
	Current father smoking	No	4696	60.6
		Yes	3172	40.0
	Current mother smoking	No	7560	90.1
		Yes	832	9.9
	Someone to consult for child-rearing	No	204	2.4
		Yes	8212	97.6
	Father's support	no	424	5.3
		yes	7505	94.7
	Watching television	<2 hours	4076	48.7
		≥2 hours	4288	51.3

Table 3. Estimation effects of sleep habits (bedtime, sleep duration) on problematic behaviors

	odds ratio	*p* value	95% CI
Risk factors			
Bedtime	1.07	0.001	1.03–1.11
Sleep duration	0.92	0.002	0.87–0.97
Confounding factors			
Group A			
Watching television (≥2 hours) + abnormality at birth (yes)	2.34	<0.001	1.87–2.94
Group B			
Watching television (≥2 hours) + abnormality at birth (no) + father's support (no)	2.15	<0.001	1.75–2.65
Group C			
Watching television (≥2 hours) + abnormal at birth (no) + father's support (yes)	1.43	<0.001	1.26–1.63
Group D			
Watching television (<2 hours) + birth order (first child)	1.38	<0.001	1.20–1.59
Group E (reference)			
Watching television (<2 hours) + birth order (second child)			

CI, confidence interval.

Table 4. Comparison of average bedtime among five group profiles[a]

	Average bedtime (hours)	SD (minutes)
Group A		
Watching television (≥2 hours) + abnormality at birth (yes)	21:32*	79
Group B		
Watching television (≥2 hours) + abnormality at birth (no) + father's support (no)	21:35*	74
Group C		
Watching television (≥2 hours) + abnormality at birth (no) + father's support (yes)	21:22*	69
Group D		
Watching television (<2 hours) + birth order (first child)	21:08	65
Group E (reference)		
Watching television (<2 hours) + birth order (second child)	21:13	77

SD, standard deviation.

[a]Groups constructed using individual and environmental factors.

*Indicates statistical significance compared with Group E (p<0.001)

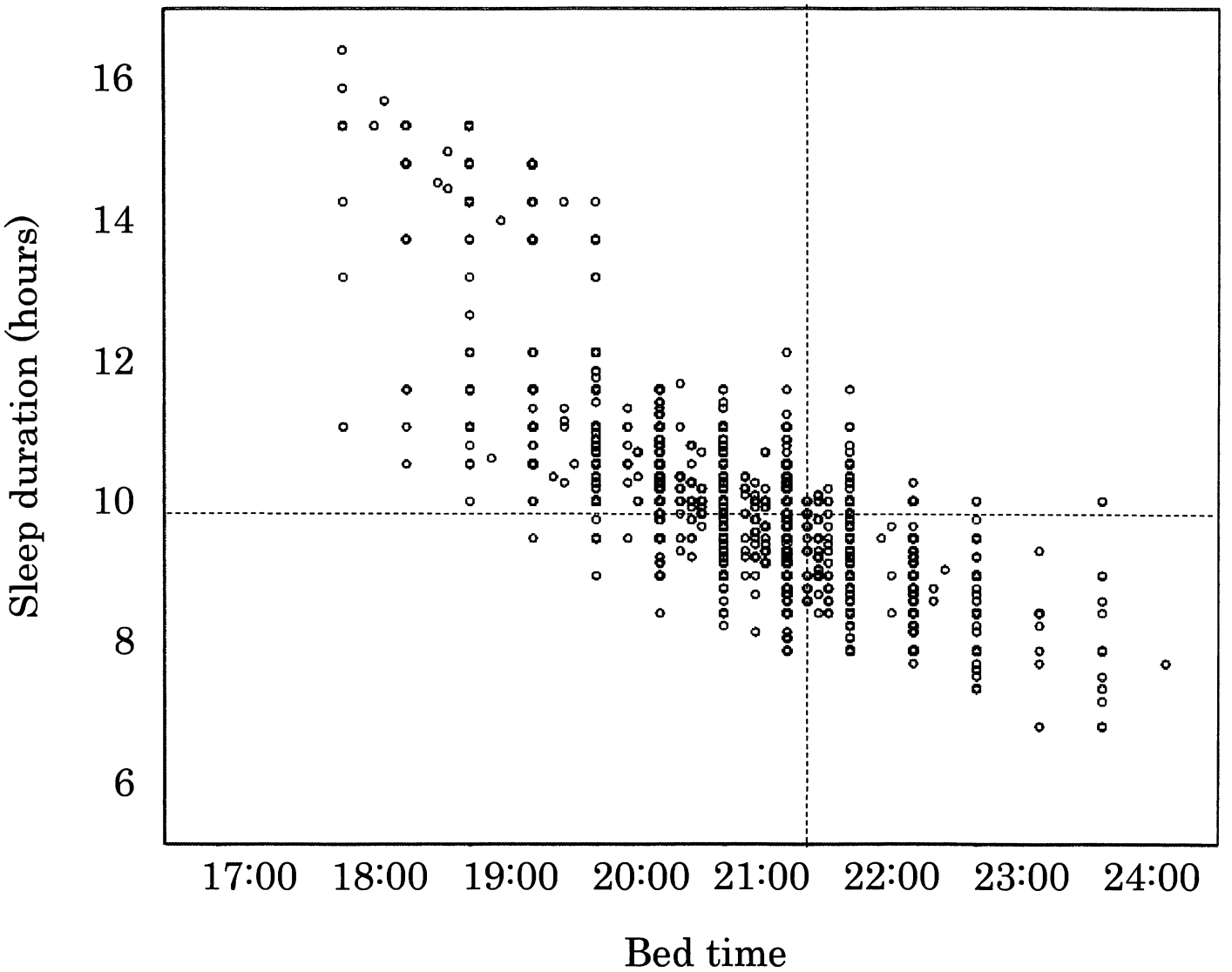
Table 5. Comparison of average sleep duration among five group profiles[a]

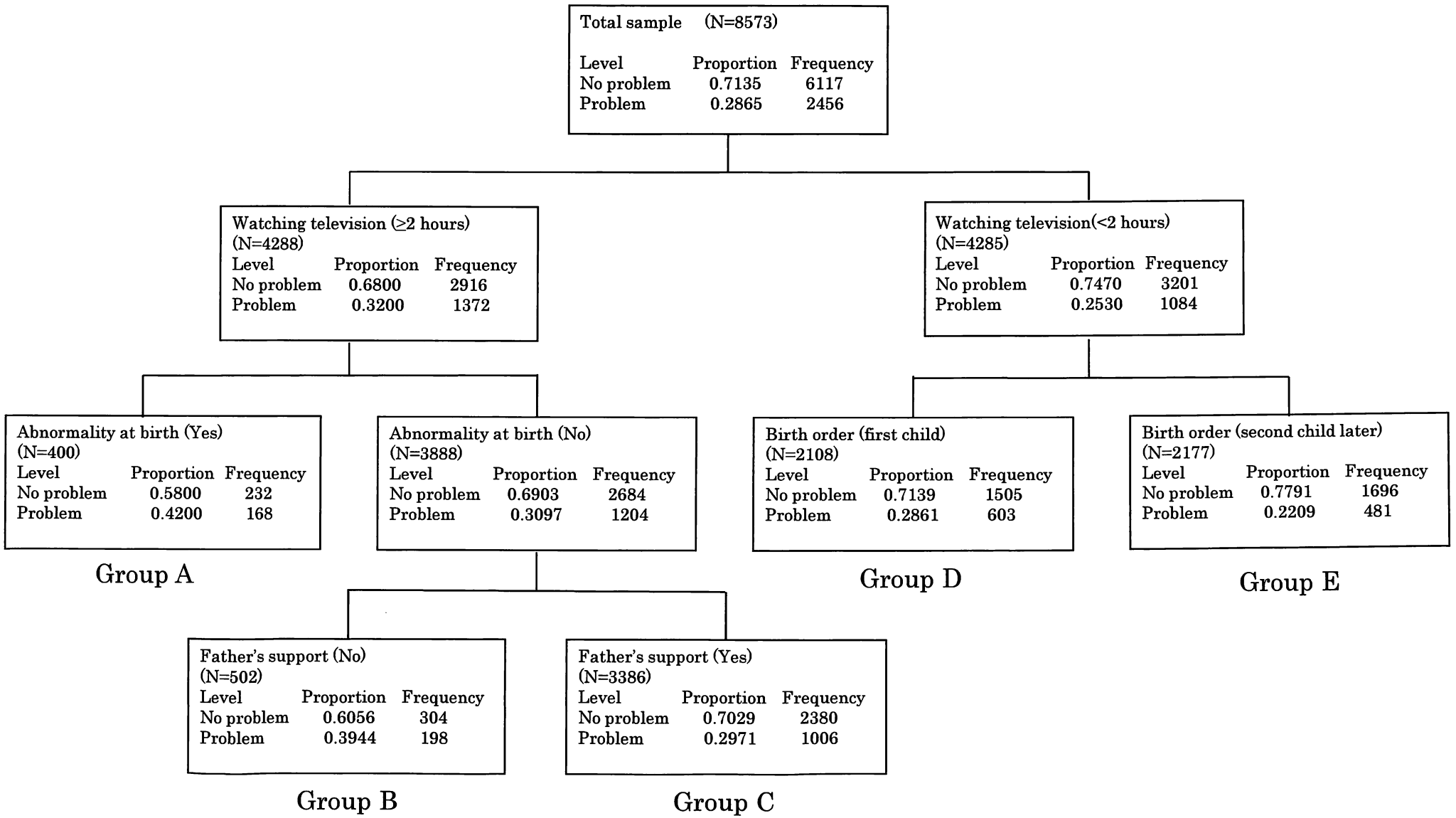
	Average sleep duration (hours)	SD (hours)
Group A		
Watching television (≥2 hours) + abnormal at birth (yes)	9.8*	1.0
Group B		
Watching television (≥2 hours) + abnormal at birth (no) + father's support (no)	9.7*	1.0
Group C		
Watching television (≥2 hours) + abnormal at birth (no) + father's support (yes)	9.9*	0.9
Group D		
Watching television (<2 hours) + birth order (first child)	9.9	0.9
Group E (reference)		
Watching television (<2 hours) + birth order (second child)	10.0	0.9

SD, standard deviation.

[a]Groups constructed using individual and environmental factors.

*Indicates statistical significance compared with Group E ($p<0.001$)


Sleep duration (hours)
16
14
12
10
8
6
17:00
18:00
19:00
20:00
21:00
22:00
23:00
24:00
Bed time


Total sample (N=8573)
Level Proportion Frequency
No problem 0.7135 6117
Problem 0.2865 2456
Watching television (≥2 hours)
(N=4288)
Level Proportion Frequency
No problem 0.6800 2916
Problem 0.3200 1372
Watching television(<2 hours)
(N=4285)
Level Proportion Frequency
No problem 0.7470 3201
Problem 0.2530 1084
Abnormality at birth (Yes)
(N=400)
Level Proportion Frequency
No problem 0.5800 232
Problem 0.4200 168
Abnormality at birth (No)
(N=3888)
Level Proportion Frequency
No problem 0.6903 2684
Problem 0.3097 1204
Birth order (first child)
(N=2108)
Level Proportion Frequency
No problem 0.7139 1505
Problem 0.2861 603
Birth order (second child later)
(N=2177)
Level Proportion Frequency
No problem 0.7791 1696
Problem 0.2209 481
Group A
Group D
Group E
Father's support (No)
(N=502)
Level Proportion Frequency
No problem 0.6056 304
Problem 0.3944 198
Father's support (Yes)
(N=3386)
Level Proportion Frequency
No problem 0.7029 2380
Problem 0.2971 1006
Group B
Group C