ISSN 1229-8565 (print)
한국지역사회생활과학회지
Korean J Community Living Sci
http://doi.org/10.7856/kjcls.2018.29.3.379

ISSN 2287-5190 (on-line)
29(3): 379~389, 2018
29(3): 379~389, 2018

Age- and Sex-Related Differences in Sleep Patterns Among Korean Young Children

Jinwook Kim · Youjeong Park[1)†]

Dept. of Child Development and Education, Myongji University, Seoul, Korea

Dept. of Child Development and Family Studies, Pusan National University, Busan, Korea[1)]

한국 유아의 수면양상 발달 및 성차

김 진 욱 · 박 유 정[1)†]

명지대학교 아동학과 · 부산대학교 아동가족학과[1)]

ABSTRACT

The present study examined the age- and sex-related differences in the sleep patterns among Korean children aged between 2 and 5 years (N = 1,413). Data on the children's bedtime, wake time, nap duration and nighttime sleep duration were drawn from a larger dataset collected by the Korean Institute for Child-Rearing Policy (KICP). The findings indicated that the children's bedtime and wake time shifted gradually to earlier times with increasing age. Their 24h nap duration and total sleep duration shortened dramatically with age, whereas the nighttime sleep increased then decreased to a modest degree. Although boys showed earlier wake times and shorter nighttime sleep than girls at all ages, boys did not show a shorter total sleep than girls until the age of 4 years, after which the majority of children began the single-phasic sleep/wake pattern. At all ages, a considerable proportion of children exhibited a shorter 24h total sleep duration than the recommended total sleep duration. The results suggest that Korean young children may undergo sleep deficiency and an acute reduction of naps while they move from a bi-phasic to single-phasic sleep/wake pattern.

Key words: age-related changes, preschool children, sex differences, sleep patterns

I. Introduction

Adequate sleep plays a vital role in young children's physical health and cognitive functioning. Young children with sufficient sleep show a lower number of medically attended injuries (Koulouglioti et al. 2008), understand others' emotions better (Berger et al. 2012), and learn more vocabulary

This work was supported by a 2-year Research Grant of Pusan National University
Received: 13 July, 2018 Revised: 25 July, 2018 Accepted: 31 July, 2018
†Corresponding Author: Youjeong Park Tel: +82-51-510-2839 E-mail: youjeongpark@pusan.ac.kr

(Friedrich et al. 2017) than those with insufficient sleep. At the same time, young children experience dramatic changes in sleep/ wake patterns during the early childhood. Namely, children's poly-phasic sleep/ wake patterns transform into a single-phasic one, as their nocturnal sleep becomes increasingly consolidated and their nap duration decreases (Iglowstein et al. 2003; Acebo et al. 2005; Crabtree & William 2009). Thus, an important developmental task for young children is to undergo the transition of sleep patterns while taking sufficient sleep.

Although a large number of studies have addressed the age-related changes of sleep patterns, few studies have closely examined how young children transit from poly-phasic sleep wake patterns to a single-phasic one during the preschool period. Some studies examined sleep pattern development over broader age ranges (e.g., birth to 16 years; Iglowstein et al. 2003. These studies have highlighted the most dramatic change in sleep patterns occurring in the preschool period (i.e., decrease in nap duration), but not elucidated relatively smaller changes in other sleep variables during the preschool period. For instance, Iglowstein and colleagues (2003) demonstrated that children's wake time did not change from birth to 16 years. Other studies examined sleep patterns focusing on the preschool period, but collapsed the age groups (e.g., Jalilolghadr et al. 2012; Mindell et al. 2013), failing to provide developmental data on how children's sleep variables change while children transit to a single-phasic sleep-wake pattern. Findings from these studies mainly focused on the relationships among sleep measures and other behavioral measures (Lavigne et al. 1999; Owens et al. 2005; Hysing et al. 2016) or cross-cultural comparisons of sleep patterns (Mindell et al. 2013). Thus, except for the dramatic change of nap, it remains unclear whether and how various sleep variables (e.g., bedtime, wake time, and nighttime sleep) change during the preschool period.

Child sleep/wake patterns are affected not only by biological maturation but also by cultural and ecological environments. One previous cross-cultural study has shown that children in predominantly-Asian countries overall exhibit later bedtimes and shorter nighttime sleep than those in predominantly-Caucasian countries (Mindell et al. 2013). Moreover, children in predominantly-Asian countries have been shown to keep regular napping until a later age relative to those in predominantly-Caucasian countries. Therefore, it has been argued that the longer nap duration of Asian children compensates for their shorter nighttime sleep, resulting in *no* difference in 24h total sleep between the two broad cultures (Mindell et al. 2013).

However, it is unclear how well the findings about children in 'predominantly-Asian countries' from a broad cross-cultural study apply to Korean young children. First, the findings in the previous cross-cultural study were based on the sleep measures averaged over several Asian countries (e.g., China, Japan, Korea, Philippines, Singapore, and Thailand) and averaged over different age groups of the preschool period. Moreover, research has shown that Korean infants (Ahn et al. 2016), primary school children (Seo et al. 2010), and adolescents (Yang et al. 2006) exhibit shorter 24h total sleep than their age mates in other countries, raising the possibility that Korean preschool children also exhibit shorter 24h total sleep than their peers in other countries.

Korea has socio-cultural environment that might contribute to characteristics of young children's sleep patterns that are different from those of children from other countries. First, Korean young children exhibit a high rate of enrollment in childcare institutions. As an example, 92.3% of the children from age 3 to 5 years were enrolled in nursery schools or kindergartens in 2014 (Korean Ministry of Health and Welfare 2014). This high enrollment rate results in young children's nap duration that largely depends upon the institutions' nap schedules. Second, Korean parents emphasize early education to an extensive degree, having their young children receive various lessons such as language, mathematics, sports and music (Woo & Hedges 2015). A considerable proportion of Korean parents (30.4%) exhibit negative attitudes toward mandatory nap time in childcare institutions, and want the institutions to provide educational activities instead of nap time (Kwon 2013). Reflecting the parental needs, some childcare institutions replace the nap time with a time for educational activities. Indeed, a recent report indicated that only 48.5% of Korean kindergarten teachers actually ran regular nap time in their class (Kim et al. 2014). These socio-cultural surroundings may together cause Korean young children to reduce their napping at a fast rate and quit napping at an earlier age in preschool period. If the reduced napping is not compensated, it might cause sleep deficit among Korean young children. To our knowledge, no studies have examined this issue, although a few studies examining Korean children's time use have provided some information about preschoolers' total sleep duration (e.g., Chin & Lee 2010).

Lastly, sex differences in preschoolers' sleep patterns have received little attention, with inconsistent findings. A number of studies have failed to find sex differences in preschoolers' bedtime, sleep onset and end times, nap duration, and total 24h sleep duration (Lavigne et al. 1999; Acebo et al. 2005; Goodlin-Jones et al. 2008), suggesting that sex may not impact sleep variables during the preschool years. However, a few studies did find significant sex differences in young children's sleep variables. For instance, in a study examining American children 1 to 5 years, bedtime was earlier in boys relative to girls at 48 months of age (Acebo et al. 2005). Also, girls showed longer nocturnal sleep than boys among Iranian preschoolers (Jalilolghadr et al. 2012). Interestingly, these findings are in line with findings from older subjects. That is, it has been often shown that females take more 24h total sleep than males among primary school children (Gulliford et al. 1990; Sadeh et al. 2000; Liu et al. 2005; Ng et al. 2005; but see Seo et al. 2010; Biggs et al. 2013), adolescents (Fredriksen et al. 2004; but Russo et al. 2007 for weekends only; Olds et al. 2010), and young adults (Lauderdale et al. 2006; Kabrita & Hajjar-Muça 2016). Thus, another possibility is that sex may begin to influence child sleep patterns from the preschool period. Examining sex differences in sleep variables among preschool children may shed light on whether some gender differences in sleep patterns begin to emerge in early childhood.

In sum, the present study aimed to closely examine the age- and sex-related differences in sleep patterns of Korean preschool children from age 2 to 5 years. It also aimed at examining the prevalence of nap and sleep deficiency among Korean young children. The results would allow a close look at the transition process of Korean

young children's sleep patterns, and shed light on culture-specific characteristics of sleep patterns.

II. Method

1. Data and Sample

The data for this study came from the 2010-2013 Panel Study of Korean Children (PSKC), a nationally representative cohort study of 2,150 Korean children and their families. The PSKC used a stratified multi-stage sampling technique. In the first stage, the nation was stratified per each of its six zones, and sampling was conducted in terms of medical institutes whose annual delivery count was 500 or more. In the second stage, sampling was performed in terms of households with a neonate born from April to July 2008 in the sampled medical institutes. Specifically, PSKC was explained to mothers at individual medical institute, and consent was obtained for participation in the study. The exclusion criteria were as follows: the mother's inability to communicate in Korean, the mother's poor postpartum health, serious illness of the infant or the mother, the infant who was put up for adoption, the infant from a multiple pregnancy, and the mother aged 18 years or less. It resulted in a preliminary sample of 2,562 households. In the third stage, 2,150 households that had actually responded to the main study were confirmed as the study sample.

Among these, 1,413 households comprised the sample of the present study, with complete information from the questions regarding child's sleep/wake patterns from 2010 to 2013. The age range of the present sample at the time of data collection was 24-32 months (M = 26.26 months, SD = 1.30 months) in 2010, 36-43 months (M = 38.73 months, SD = 1.40 months) in 2011, 48-54 months (M = 51.05 months, SD = 1.20 months) in 2012, and 60-66 months (M = 62.65 months, SD = 1.30 months) in 2013. Information of other demographic background is shown in Table 1.

Table 1. Demographics of the participants

	N	%
Sex		
Boy	729	51.6
Girl	684	48.4
Province of residence		
Seoul	182	12.9
Gyeonggi/Incheon	421	29.8
Daejeon/Chungcheong/Gangwon	201	14.2
Daegu/Gyeongbuk	189	13.4
Busan/Ulsan/Gyeongnam	247	17.5
Gwangju/Jeolla	173	12.2
Birth order		
First	662	46.9
Second	590	41.8
Third or later	161	11.3
Mothers' education		
High school or lower	380	27.0
College/university	875	62.0
Post-graduate	61	4.3
Refused to answer	88	6.2
Missing	9	0.6
Mothers' employment status		
Employed (Full-time or Part-time)	457	32.3
Student	5	0.4
Home	950	67.2
Refused to answer	1	0.0007

2. Procedure

Parents annually completed a questionnaire that requested mothers to provide information on their child's bedtime, wake time, and nap durations at home and childcare institutions if applicable. Based on the mothers' responses to these question

items, we calculated the child's 24h total nap duration (TND), the amount of nighttime sleep (TNS), and 24h total sleep time (TST; sum of TND and TNS). The item regarding whether the child slept well all night or had broken sleep was not consistently included in the questionnaire. Therefore, data from the item were not used in the present study.

3. Data analyses

To examine age- and sex-related differences in each sleep variable, we performed a series of 2 (Sex: Male vs. Female) x 4 (Age: 2 vs. 3 vs. 4 vs. 5 years) mixed-model analyses of variance (ANOVAs) in which age was a within-subject variable and sex served as a between-subject variable. All significant main effects of age were followed up with pair-wise comparisons using a Bonferroni correction (the overall P = 0.05). Significant age x sex interactions were further examined using independent t tests (two-tailed). Also, Chi-square test was used to compare the prevalence of napping and sleep deficit across age and sex.

III. Results

1. Age and sex differences in bedtime, wake time, TND, TNS, and TST

Table 2 presents the means and standard deviations of the sleep variables. First, the mixed-

Table 2. Means and standard deviations of the sleep variables

	Age			
	2 yrs.	3 yrs.	4 yrs.	5 yrs.
Bedtime				
Boys	22:07 (0:53)	21:57 (0:52)	21:46 (0:46)	21:46 (0:43)
Girls	22:08 (0:52)	21:55 (0:50)	21:43 (0:48)	21:42 (0:43)
Total	22:07 (0:52)	21:56 (0:51)	21:45 (0:47)	21:44 (0:43)
Wake time				
Boys	7:50 (0:49)	7:46 (0:43)	7:38 (0:39)	7:33 (0:37)
Girls	8:00 (0:53)	7:50 (0:44)	7:43 (0:36)	7:38 (0:38)
Total	7:55 (0:51)	7:48 (0:43)	7:40 (0:37)	7:36 (0:38)
TND				
Boys	1:46 (0:33)	1:13 (0:41)	0:22 (0:37)	0:07 (0:21)
Girls	1:38 (0:32)	1:09 (0:40)	0:22 (0:37)	0:08 (0:21)
Total	1:43 (0:32)	1:12 (0:40)	0:22 (0:37)	0:07 (0:21)
TNS				
Boys	9:43 (0:53)	9:49 (0:54)	9:51 (0:46)	9:47 (0:43)
Girls	9:51 (0:49)	9:55 (0:51)	9:59 (0:47)	9:56 (0:43)
Total	9:47 (0:51)	9:52 (0:53)	9:55 (0:47)	9:51 (0:43)
TST				
Boys	11:30 (0:57)	11:03 (0:58)	10:14 (0:54)	9:55 (0:45)
Girls	11:30 (0:55)	11:05 (0:56)	10:21 (0:53)	10:05 (0:44)
Total	11:30 (0:56)	11:04 (0:57)	10:18 (0:54)	9:59 (0:45)

Note. TND = Total nap duration; TNS = Total nighttime sleep; TST = Total sleep time

model ANOVA performed on bedtime yielded a significant main effect of age, F (3, 4233) = 116.43, P 〈 0.001. Pairwise comparisons using Bonferroni correction revealed significant differences in bedtime between all possible pairs of age (Ps 〈 0.001) except for between the ages 4 and 5 years (P = 1.0). Thus, children's bedtime steadily shifted to earlier times until the age of 4 years (from 22:07 to 21:45; by 22 min), and then remained approximately the same between ages 4 and 5 years. There was no sex difference in bedtime.

Second, the mixed-model ANOVA for wake time yielded a significant main effect of age, F (3, 4233) = 97.69, P 〈 0.001. Pairwise comparisons revealed significant differences between all possible pairs of age (all Ps 〈 0.001), demonstrating that children's wake time gradually moved to earlier times from age 2 to 5 years (from 7:55 to 7:36; by 19 min). In addition, the analysis yielded a significant main effect of sex, F (1, 1411) = 11.64, P = 0.001, indicating that boys (M = 7:42, SD =0:42) woke up earlier than girls (M = 7:48, SD = 0:43) across ages.

Third, the analysis performed on TND revealed a strongly significant main effect of age, F (3, 4233) = 2647.75, P 〈 0.001, and a significant main effect of sex, F (1, 1411) = 7.66, P = 0.006, as well as a significant age x sex interaction, F (3, 4233) = 4.05, P = 0.007. Pairwise comparisons indicated significant differences between all possible pairs of age (all Ps 〈 0.001), indicating that TND significantly declined each year from age 2 to 5 years. At the same time, boys (M = 1h 46min, SD = 0h 33min) had longer TND than girls (M = 1h 38min, SD = 0h 32min) at age 2, t(1411) = 4.21, P 〈 0.001. There was no sex difference in TND at other ages, ts 〈 1.77, *ns*, demonstrating that boys and girls did not differ in TND after the age of 3 years.

Fourth, the analysis performed on TNS revealed significant main effects of age, F (3, 4233) = 8.70, P 〈 0.001, and sex, F (1, 1411) = 19.46, P 〈 0.001. Pairwise comparisons indicated significant differences in TNS between all pairs of age, except for between 3 and 4 years, and between 3 and 5 years. Thus, TNS increased from age 2 to 3 years (9h 47 min to 9h 52 min; by 5 min), remained approximately the same from age 3 to 4 years, and then declined from age 4 to 5 years (9h 55 min to 9h 51min; by 4 min). Furthermore, boys (M = 9h 48min, SD = 0h 34min) had shorter TNS than girls (M = 9h 56min, SD = 0h 32min) regardless of age.

Lastly, the analysis of TST yielded significant main effects of age, F (3, 4233) = 1056.78, P 〈 0.001, and sex, F (1, 1411) = 7.37, P = 0.007, as well as a significant age x sex interaction, F (3, 4233) = 3.02, P = 0.029. The follow-up analyses revealed that TST significantly decreased each year in both girls and boys, all Ps 〈 0.001. However, the interaction arose because boys and girls did not differ in their TST at ages 2 and 3 years, ts 〈 1, but then boys showed significantly shorter TST than girls at ages 4, t(1411) = 2.51, P = 0.012, and 5 years, t(1411) = 4.12, P 〈 0.001.

2. Prevalence of napping and sleep deficit

Next, we examined the prevalence of nap and that of sleep deficit, which was operationalized as TST shorter than the minimum TST recommended by the U.S. National Sleep Foundation (i.e., 11h for 2-year-olds; 10h for 3- to 5-year-olds; Hirshkowitz et al., 2015).

First, 99.6% of the children took naps at 2 years of age; 84.0% took naps at 3 years; 32.7% of

children at 4 years, and 15.1% at 5 years, a distribution that was significantly different, χ^2 (3, N = 1,413) = 2835.81, P < 0.001. Thus, the percentage of nap-takers continually decreased from age 2 to 5 years, with a particularly sharp decrease between the ages of 3 and 4 years. There was no sex difference in nap prevalence.

Second, sleep deficit was found in 19.8% at 2 years, 7.21% at 3 years, 25.13% at 4 years, and 34.9% at 5 years of age. Thus, approximately one out of four children at 4 years, and one out of three children at 5 years indicated sleep deficit.

3. Additional Analysis: Associations between TND and other sleep variables

Additionally, we examined whether TND was linked to other sleep variables in a correlation analysis. As shown in Table 3, longer TND was associated with later bedtime and shorter nocturnal sleep at all ages (all Ps < 0.001). Furthermore, longer TND was linked to longer TST at ages 2 and 3 years, but with shorter TST at age 5 years. There was no relationship between TND and TST at age 4 years. TND was not associated with wake time.

Table 3. Correlations between the TND and other sleep variables

	Bedtime	Wake Time	TNS	TST
2 yrs.	0.138***	0.008	−0.134***	0.450**
3 yrs.	0.259***	−0.022	−0.269***	0.462**
4 yrs.	0.186***	−0.011	−0.196***	0.524
5 yrs.	0.183***	0.028	−0.159***	−0.159**

** P < 0.01, *** P < 0.001

IV. Discussion

The purpose of this study was to examine the age- and sex-related differences in sleep patterns among Korean young children to better understand how Korean children transit from poly-phasic sleep wake patterns to a single-phasic one during the preschool period. The results indicated that children's bedtime and wake time gradually advanced to earlier times. Also, TND and TST dramatically shortened with age, whereas TNS increased and then decreased modestly. In addition, the results showed that boys had shorter TNS and earlier wake time than girls throughout the preschool years. By the age of 4 years, the majority of children quit napping, and boys' 24h total sleep was shorter than that of girls. At all ages, a considerable proportion of children exhibited TST shorer than the minimum TST recommended by U.S National Sleep Foundation. Below, we discuss these findings in more detail.

Over the preschool years, children's bedtime and wake time gradually shifted to earlier times. This finding is inconsistent with the previous findings that bedtime increasingly delays with age while wake time remains constant among Swiss children from birth to 16 years of age (Iglowstein et al. 2003) and that bedtime and wake time show no age-related differences among 2- to 5-year-old American children (Lavigne et al. 1999). Although the current study cannot specify the mechanisms underlying the shifts of bedtime and wake time in Korean children, one possibility is that the acute decrease in TND causes sleep pressure earlier in the evening and subsequent shift of bedtime. Our additional finding showing the association between children's TND and bedtime may lend indirect support for this possibility. In addition, the wake

time shift may be related to the rate of childcare enrollment, which increases with child age. Most early childcare programs in Korea start early in the morning. Thus, attendance to the childcare institutions may advance children's wake time. The shift of wake time may be also partly attributed to parents' high interest in child education. Namely, it is possible that Korean parents guide their children's wake time to earlier times so that they can get gradually prepared for the school start time (approximately 8:40 A.M.).

The most dramatic age-related change was evident in TND, consistent with previous findings (e.g., Fukuda & Sakashita 2002). Particularly, the yearly decrease of TND was the greatest between the ages of 3 and 4 years (50 min) and the second greatest between the ages of 2 and 3 years (31 min). TND decreased by 15 min between 4 and 5 years. Thus, although TND declines over the preschool years, the decrease appears sharper in earlier preschool years. Related to this developmental pattern of TND, our results regarding nap prevalence show that approximately half of Korean children quit napping between ages 3 and 4 years. Therefore, the majority of children have stopped napping by 4 years of age.

Interestingly, the nap prevalence in Korean 4-year-old children is much lower than that of Brazilian 4-year-olds, of whom 88.9% take naps for 1h or longer (Halal et al. 2016). Also of note, Korean children's nap prevalence in the current study parallels the average nap prevalence of several Asian countries at age 3 years (84% and 86.9%, respectively), but is far below than the average nap prevalence of Asian countries at age 4 years (32.7% versus 75.4% respectively) and 5 years (15.1% versus 60.7% respectively; Mindell et al. 2013). These comparisons suggest that Korean preschool children stop napping at an younger age compared to their peers in other Asian countries. Thus, our results regarding TND and nap prevalence together highlight that Korean young children experience a fast reduction of TND and earlier cessation of napping relative to children in other Asian countries. Possibly, childcare institutions' replacement of nap time with educational activities (Kwon 2013), parents' negative attitudes toward child napping, and parents' enthusiasm about early education (Woo & Hedges 2015) may play a role in the precocious quit of napping. Future work should address this possibility.

The present study showed that TNS increased from 2 to 3 years and declined from 4 to 5 years. This finding is novel given the previous finding that TNS does not vary with age among American children of 2 to 5 years (Lavigne et al. 1999). Possibly, the earlier increase of TNS among Korean children is due to their sharp reduction of TND in earlier preschool years. However, it should be noted that the degree of TNS changes were only modest (approximately 5 min). Thus, a potential implication is that children cannot compensate the decreased TND with the increased TNS, which might lead to children's sleep deficiency. In addition, the decrease of TNS was evident after the age of 4 years. Although this might reflect that older preschool children need shorter TST than younger preschoolers, additional work is needed to understand what factors, biological, socio-cultural, or in combination, lead children to take the shorter TNS.

Our results indicate that TST decreases in an acute manner during the preschool years. This age-related change of TST highly resembles the

age-related decline of TND, suggesting that the steep decrease of TST may arise from the sharp decrease of TND. Moreover, the proportion of children whose TSTs were shorter than the minimum TSTs recommended by the National Sleep Foundation in the U.S. (Hirshkowitz et al. 2015) increased from 7.21% to 25.13% between the ages of 3 and 4 years, during which the majority of children quit napping. Further, at age 5 years when most children no longer take naps, the proportion soared up to 34.9% (1 child out of 3 children). Furthermore, even at age 2, our 2-year-olds' average TST is 1h shorter than 12h 27 min of TST in Norwegian 2-year-olds (Hysing et al. 2016). Given that sleep plays an important role in young children's healthy development in physical, emotional, and cognitive areas (Lavigne et al. 1999; Sadeh et al. 2003; Halal et al. 2016; Hysing et al. 2016), these findings raise a concern that a considerable proportion of Korean preschool children may suffer from sleep deficit. Nonetheless, we also note that we should be cautious to determine whether Korean young children take sufficient sleep or not, based on the criterion set up for children in the U.S. and other western countries. Future work is needed to test Korean children's physical and mental functioning in relation to their TSTs.

The current study found sex differences in several sleep measures. Boys had shorter TNS than girls throughout the preschool years, consistent with the finding from Iranian children (Jalilolghadr et al. 2012). Our results also indicate that boys' total 24h sleep is about 7-10 min shorter than that of girls at ages 4 and 5 years. Although the finding is novel for preschool-aged children, it is noteworthy that greater TST in females relative to males have been found in a number of studies with primary school children, adolescents (Gulliford et al. 1990; Sadeh et al. 2000; Gaina et al. 2004; Liu et al. 2005; Ng et al. 2005; Yang et al. 2005; Biggs et al. 2013) and adults (e.g., Kabrita & Hajjar-Muca 2016). Thus, the present results suggest that some gender differences in sleep patterns may emerge from early childhood. We also note that the sex difference in TST was not evident until the age of 4 years. Possibly, 2- and 3-year-old boys could compensate their shorter TNS with naps, but could not do so at 4 and 5 years of age. However, this possibility calls for further research that systematically examines the role of naps and nocturnal sleep in boys and girls.

There are several limitations in the present study. First, our sleep measures relied on parental reports, with no use of complimentary sleep assessment tools. Recent findings suggest that parental reports on their children's sleep in questionnaires may be inaccurate (overestimating child's sleep duration) although they generally correlate well with actigraphic assessment (Sadeh 2008). Thus, for more accurate understanding of age and sex differences in Korean children's sleep patterns, future work should employ objective measures such as those from actigraphy recordings. In addition, the present study examined the quantitative aspects of sleep patterns only, since questions regarding qualitative aspects of sleep were not consistently included in PSKC. Future research should investigate qualitative aspects of sleep such as sleep efficiency to fully understand the developmental changes and sex differences in sleep patterns during the early childhood. Moreover, our study could not provide information of whether young children's sleep patterns vary with

weekday-weekend difference.

V. Summary and Conclusion

Despite the limitations, the present study is among the first that closely examines the developmental changes and sex differences in sleep patterns of Korean preschoolers. Also, to our knowledge, it is the first to examine the prevalence of nap and sleep deficit among Korean young children using a large-scale, nationally representative longitudinal data. Our findings indicate that not only nap duration but also other sleep variables continue to change during the preschool period. Also, findings from this study suggest that Korean children may undergo an acute reduction of nap and subsequent sleep deficiency while they move from a bi-phasic to a single-phasic sleep/wake pattern. Lastly, the findings suggest that some gender differences in sleep patterns may emerge from early childhood. Together, this study provides a stepping stone to develop research that investigates the effects of early cessation of napping and acute reduction of total sleep on child health and to develop sleep education programs for parents and teachers of young children in Korea.

References

Ahn Y, Williamson AA, Seo H, Sadeh A, Mindell J(2016) Sleep patterns among South Korean infants and toddlers: global comparison. J Korean Med Sci 31, 261-269. doi:10.3346/jkms.2016.31.2.261

Acebo C, Sadeh A, Seifer R, Tzischinsky O, Hafer A, Carskadon M(2005) Sleep/wake patterns derived from activity monitoring and maternal report for healthy 1- to 5-year-old children. Sleep 28, 1568-1577. doi:10.1093/sleep/28.12.1568

Berger RH, Miller AL, Seifer R, Cares SR, Lebourgeois MK (2012) Acute sleep restriction effects on emotion responses in 30- to 36-month-old children. J Sleep Res 21, 235-246. doi:10.1111/j.1365-2869.2011.00962.x

Biggs SN, Lushington K, Martin J, van den Heuvel C, Kennedy D(2013) Gender, socio-economic, and ethnic differences in sleep patterns in school- aged children. Sleep Med 14, 1304-1309. doi:10.1016/j.sleep.2013.06.014

Chin M, Lee Y(2010) Young children's time-use according to employment status of mothers. J Korean Home Econ Assoc 48, 43-56

Crabtree VM, William NA(2009) Normal sleep in children and adolescents. Child Adolescent Psych Clin 18, 799-811. doi:10.1016/j.chc.2009.04.013

Dayyat EA, Spruyt K, Molfese D, Gozal D(2011) Sleep estimates in children: parental versus actigraphic assessments. Nature Sci of Sleep 3, 115-123. doi:10.2147/NSS.S25676

Fukuda K, Sakashita Y(2002) Sleeping pattern of kindergarteners and nursery school children: function of daytime nap. Perceptual Motor Skills 94, 219-228. doi:10.2466/PMS.94.1.219-228

Friedrich M, Wilhelm I, Molle M, Born J, Friederici AD (2017) The sleeping infant brain anticipates development. Current Biol 27, 2374-2380. doi:10.1016/j.cub.2017.06.070

Fredriksen K, Rhodes J, Reddy R, Way N(2004) Sleepless in Chicago: tracking the effects of adolescent sleep loss during the middle school years. Child Dev 75, 84-95. doi:10.1111/j.1467-8624.2004.00655.x

Goodlin-Jones BL, Tang K, Liu J, Anders TF(2008) Sleep patterns in preschool-age children with autism, developmental delay, and typical development. J Am Academy Child Adolescent Psych 47, 930-938. doi:10.1097/CHI.0b013e3181799f7c

Gulliford MC, Price CE, Rona RJ, Chinn S(1990) Sleep habits and height at ages 5 to 11. Arch Disease Childhood 65, 119-122. doi:10.1136/adc.65.1.119

Halal C, Matijasevich A, Howe L, Santos I, Barros F, Nunes M(2016) Short sleep duration in the first years of life and obesity/overweight at age 4 years: A birth cohort study. J Pediatr 168, 99-103. doi:10.1016/j.jpeds.2015.09.074

Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, DonCarlos L (2015) National sleep foundation's sleep time duration recommendations: methodology and results summary. Sleep Health 1, 40-43. doi:10.1016/j.sleh.2014.12.010

Hysing M, Sivertsen B, Garthus-Niegel S, Eberhard-Gran M(2016) Pediatric sleep problems and social-emotional problems. A population-based study. Infant Behav Dev 42, 111-118. doi:10.1016/j.infbeh.2015.12.005

Iglowstein I, Jenni OG, Molinari L, Largo RH(2003) Sleep duration from infancy to adolescence: Reference values and generational trends. Pediatr 111, 302-307. doi:10.1542/peds.111.2.302

Iwasaki M, Iwata S, Iemura A, Yamashita N, Tomino Y,

Anme T, Yamagata Z, Iwata O, Matsuish T(2010) Utility of subjective sleep assessment tools for healthy preschool children: a comparative study between sleep logs, questionnaires, and actigraphy. J Epidemiol 20, 143-149. doi:10.2188/jea.JE20090054

Jalilolghadr S, Hashemi S, Javadi M, Esmailzadehha N, Jahanihashemi H, Afaghi A(2012) Sleep habits of Iranian pre-school children in an urban area: late sleeping and sleep debt in children. Sleep Biological Rhythms 10, 154-156. doi:10.1111/j.1479-8425.2011.00516.x

Kabrita C, Hajjar-Muça TA(2016) Sex-specific sleep patterns among university students in Lebanon: impact on depression and academic performance. Nature Sci Sleep 8, 189-196. doi:10.2147/NSS.S104383

Korean Ministry of Health and Welfare(2014) 2014 Statistics. Seoul

Koulouglioti C, Cole R, Kitzman H(2008) Inadequate sleep and unintentional injuries in young children. Public Health Nurs 25, 106–114. doi:10.1111/j.1525-1446.2008.00687.x

Kwon HJ(2013) Requirements of the parents on daily nap routine in the kindergarten. Korea J Child Care Educ 82, 185-206

Kim ES, Lee JH, Kim HJ, Bae JA(2014) Comparative analysis of kindergartens and nursery schools in Korea: policies and requirement. Korea Institute of Child Care and Education

Lavigne JV, Arend R, Rosenbaum D, Smith A, Weissbluth M, Bennis HJ(1999) Sleep and behavior problems among preschoolers. J Dev Behav Pediatr 20, 164-169. doi:10.1097/00004703-199906000-00005

Liu X, Liu L, Owens JA, Kaplan DL(2005) Sleep patterns and sleep problems among school children in the United States and China. Pediatr 115, 241-249. doi: 10.1542/peds.2004-0815F

Lauderdale DS, Knutson KL, Yan LL, Rathouz PJ, Hulley SB, Sidney S, Liu K(2006) Objectively measured sleep characteristics among early-middle-aged adults: The CARDIA study. Am J Epidemiol 164, 5-16. doi: 10.1093/aje/kwj199

Mindell J, Sadeh A, Kwon R, Goh DY(2013) Cross-cultural differences in the sleep of preschool children. Sleep Med 14, 1283-1289. doi:10.1016/j.sleep.2013.09.002

Ng DK, Kwok KL, Cheung JM, Leung SY, Chow PY, Wong WH(2005) Prevalence of sleep problems in Hong Kong primary school children: a community-based telephone survey. Chest 128, 1315-1323. doi:10.1378/chest.128.3.1315

Olds T, Blunden S, Petkov J, Forchin F(2010) The relationships between sex, age, geography and time in bed in adolescents: a meta-analysis of data from 23 countries. Sleep Med Rev 14, 371-378. doi:10.1016/j.smrv.2009.12.002

Owens JA, Fernando S, McGuinn M(2005) Sleep disturbance and injury risk in young children. Behav Sleep Med 3, 18-31. doi:10.1207/s15402010bsm0301_4

Russo PM, Bruni O, Lucidi F, Ferri R, Violani C(2007) Sleep habits and circadian preference in Italian children and adolescents. J Sleep Res 16, 163-169. doi:10.1111/j.1365-2869.2007.00584.x

Sadeh A(2008) Commentary: comparing actigraphy and parental report as measures of children's sleep. J Pediatr Psychol 33, 406-407. doi: 10.1093/jpepsy/jsn018

Sadeh A, Raviv A, Gruber R(2000) Sleep patterns and sleep disruptions in school-age children. Dev Psychol 36, 291-301. doi:10.1037/0012-1649.36.3.291

Seo WS, Sung H, Lee JH, Koo BH, Kim MJ, Kim SY(2010) Sleep patterns and their age-related changes in elementary-school children. Sleep Med 11, 569-575. doi:10.1016/j.sleep.2010.03.011

Woo HJ, Hodges NN(2015) Education fever: exploring private education consumption motivations among Korean parents of preschool children. Family Consum Sci 44, 127-142. doi:10.1111/fcsr.12131

Yang CK, Kim JK, Patel SR, Lee JH(2005) Age-related changes in sleep/wake patterns among Korean teenagers. Pediatr 115, 250-256. doi: 10.1542/peds.2004-0815G