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Gender and Age Differences in Sleep Problems in Children: Person-Oriented Approach With Multigroup Analysis

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ABSTRACT

Objective/Background: This study aimed to identify subtypes of sleep problems in children and to examine whether these patterns differed between gender and age groups.

Participants: There were 3,052 children (951 elementary school boys, 943 elementary school girls, 603 junior high school boys, and 555 junior high school girls) aged 7–16 years from two school-based epidemiological samples.

Methods: Sleep problems were measured by the Sleep Habit Questionnaire based on parent reports.

Results: Using the latent class modeling, a person-oriented approach, with a multigroup analysis, we identified four classes of sleep problems: moderate to high sleep problems (1.1%–3.1%), sleep-related breathing problems and parasomnias dominant (14.9%–21.1%), insomnias dominant and parasomnias (1.0%–3.1%), and no or low sleep problems (74.7%–81.4%), with varied prevalence rates of sleep problems across gender and age groups.

Conclusions: This study identified four classes of sleep problems across gender and age groups but with different prevalence rates of sleep problems, suggesting the complex interaction of gender and age in the subtypes of sleep problems. The gender- and age-specific interventions for sleep problems are suggested. Future studies are warranted to replicate these classes and to identify associated factors with each class.

Little literature exists regarding the subtypes or comorbidity of sleep disorders in the general population. All classification systems provide and emphasize the differential diagnoses of sleep disorders. When it comes to comorbidity, the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5; American Psychiatric Association, 2013) and the International Classification of Diseases (World Health Organization, 1992) mainly discuss how sleep disorders relate to other physical or mental disorders, but not within sleep disorders themselves. Furthermore, the International Classification of Sleep Disorders (ICSD-3; American Academy of Sleep Medicine, 2014) does not specifically discuss comorbid conditions among sleep disorders. The previous study has demonstrated that sleep problems are common in children and adolescents in Taiwan, with a range of 0.2% (sleep apnea) to 24.2% (sleep talking; Gau, 2006). Moreover, sleep problems are related to increased daytime inadvertent napping, inattention, hyperactivity, and oppositional symptoms (Gau, 2006). Thus, a better understanding of sleep problems and how they are comorbid in this population is important.

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Although there are some studies that examined how sleep problems are associated with one another, most of them used a variable-oriented, instead of person-oriented, approach (Benetó, Gomez-Siurana, & Rubio-Sanchez, 2009; Bergman & Magnusson, 1997; Ohayon, 2007; Ohayon, Roberts, Zulley, Smirne, & Priest, 2000). The variable-oriented approach focuses on the relations of variables of interest, which is usually done by summing-up of variables and capturing the linear associations between them (Bogat, Levendosky, & Eye, 2005). On the other hand, the person-oriented approach focuses on identifying a subsystem by measuring its components and studying them all together as an undivided whole (Bergman & Trost, 2006). The subsystem is typically identified by class and cluster analyses that group individuals into several subgroups based on indicator variables. Different classes or clusters obtained from a person-oriented approach are assumed to be heterogeneous in terms of indicator variables. Two advantages of the person-oriented approach, compared to the variable-oriented approach, are that (a) the person-oriented approach better reflects the characteristics of individuals that are otherwise often obscured when looking at the mean level of variables under the variable-oriented approach, and (b) the person-oriented approach is more suitable to capture some of the complex dynamic processes, mechanisms, and interactions of the phenomena, particularly in developmental research (Bergman & Magnusson, 1997; Bergman & Trost, 2006; Bogat et al., 2005). Investigations of individual development in different fields with the person-oriented approach have been proposed and called for. Due to the high heterogeneity in sleep problems and human development, the results found based on variable-oriented approach may be limited to provide essential information for the diversity in the developmental aspects of sleep problems. A better understanding of the diversity of sleep problems in children can help provide critical information for early screening, prevention, and treatment of sleep problems in childhood and adolescence.

If some subtypes of sleep problems do exist, one question that follows is whether they differ between genders or different age groups. This is an important question because studies using a variable-oriented approach have suggested that many sleep problems are common and significantly differ with age and gender (Barclay & Gregory, 2014; Gau, 2006). For example, compared to children, adolescents have poorer sleep quality, reduced sleep duration, and more sleepiness due to pubertal development (Knutson, 2005). Sleep problems including difficulty falling asleep, short sleep duration, excessive daytime sleepiness, and subjectively insufficient sleep were significantly more common in adolescent girls than boys (Ohida et al., 2004). The diversity of sleep problems between age and gender should be elucidated in a developmental psychopathology framework. Becker, Langberg, and Byars (2015) proposed a biopsychosocial and contextual model to explain the pervasiveness of sleep problems. Biological factors, such as synaptic pruning (Nofzinger, 2005) and hormone (Bixler et al., 2001), psychosocial factors, including stress and coping strategies (Jerlock, Gaston-Johansson, Kjellgren, & Welin, 2006), and contextual factors such as homework and employment (Kalenkoski & Pabilonia, 2012), may contribute to a variety of sleep-related problems.

Taken together, to better understand the comorbid conditions and possible subgroups in a variety of sleep problems in children as well as the age and gender effects, this study used one of the person-oriented analytic approaches, that is, latent class modeling (LCM) with multigroup analysis. We hypothesized that the LCM would identify classes of sleep problems in children that are similar to the broad categories in the common classification systems (i.e., dyssomnias, parasomnias, and sleep related-breathing problems) and that the prevalence rates of sleep problems would differ between gender and age groups (i.e., elementary vs. junior high school students).

**Methods**

**Participants**

A total of 3,052 children (951 elementary school boys [31.1%], 943 elementary school girls [30.9%], 603 junior high school boys [19.8%], and 555 junior high school girls [18.2%]) participated in this study. Participants were pooled from two different samples. Basic demographics for the two samples are presented in Table 1. All of the studies where the participants came from were approved by the
Research Ethics Committee of the National Taiwan University Hospital prior to the data collection. Brief descriptions of each study and participants’ characteristics are provided below.

The first sample consisted of 1,798 children who were recruited from an ongoing nationwide school-based epidemiological study from nine elementary and seven junior high schools in Northern and Central Taiwan from June 2015 to January 2016. The schools were selected using a stratified random sampling with stratification of urbanity and city. This study aimed to estimate the prevalence of child common mental disorders including sleep problems and disorders and to identify the psychosocial, individual, environmental, and familial risk factors for mental disorders in children. A preliminary result of this work on a different topic has been published (Chen, Shen, & Gau, 2017).

The second sample consisted of 1,254 children who were recruited from a school-based epidemiological study from six elementary schools and one junior high school (Grade 8) in Northern Taiwan in March 2013. The primary aim of this study was to prospectively investigate the predictors of Internet use and addiction among children and adolescents. A preliminary result of this work on a different topic has been published (Chen & Gau, 2016).

Procedures

The procedures of data collection were the same in both samples. Research assistants contacted school officials of selected schools. After obtaining permission and cooperation from the school principals, parents were invited to attend information sessions, during which they were introduced to the study and written informed consent was obtained after an explanation of the purpose and procedures of the study and reassurance of confidentiality. The parents who did not attend the information sessions received the informed consent and questionnaires brought home by the children. Only parents who agreed to participate in the study were asked to complete the questionnaire at home and return it by having their children bring it back to school in a sealed envelope within one week. An approximately US$5 coupon for convenience stores was given to participants as a reward if they participated.

Measure

The Sleep Habit Questionnaire (SHQ), a yes–no questionnaire, was used to assess current (the past 6 months) and lifetime sleep problems; items mapped onto “Sleep Disorders” in the DSM-IV (American Psychiatric Association, 1994). Only current sleep problems were used in the analyses. Information about the development of this measure was described in Gau and Soong (1995). Thirteen sleep problems were in the SHQ, including early insomnia, middle insomnia,
disturbed circadian rhythm, sleep terror, sleepwalking, sleep talking, nightmare, bruxism, snore, sleep apnea, periodic leg movements (PLMs), sleep paralysis, and narcolepsy (see Table 1). Several studies have used the SHQ to assess sleep problems in children and demonstrated the reliability and validity of this measure (Chen & Gau, 2016; Gau, 2000; Gau et al., 2007; Gau & Soong, 1995). Parent reports of the SHQ were used to assess the sleep problems in children. Moderate to almost perfect agreement in the reliabilities (kappa = .54–1.00) between clinical interviews and parent-reports for all sleep items has been reported (Gau, 2000). Current, instead of lifetime, sleep problems were used in this study to avoid finding pseudo-comorbidity, which was the association between disorders co-occurring by chance (Kraemer, Wilson, & Hayward, 2006).

Statistical analyses
We conducted all the analyses using SAS 9.4 (SAS Institute Inc., Cary, NC, USA). Prevalence rates for the 13 sleep problems were calculated separately for gender and age groups (i.e., elementary vs. junior high school students), and logistic regression analyses were conducted to determine whether sleep problems differed between groups.

There were 133 (7.4%) and 142 (11.29%) participants with missing responses for all sleep problems in sample 1 and 2, respectively. No significant differences in gender were found between the responders and the nonresponders in any sleep problem ($\chi^2 = 2.91, p = 0.087$), but a higher missing rate was found in junior high school students than in elementary school students ($\chi^2 = 10.61, p < 0.001$). The maximum likelihood methods for the estimation of missing values were used in the LCM using the SAS LCA Procedure developed by Lanza and colleagues (Lanza, Collins, Lemmon, & Schafer, 2007).

We conducted the LCM to examine the comorbid conditions of sleep problems. A basic model was fit with parameters freely estimated with no grouping variable. The number of classes was chosen based on the basic model according to four model fit indices: likelihood ratio chi-square ($G^2$), Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and entropy. The value of entropy approaching 1 indicates the clear separation of the classes (Celeux & Soromenho, 1996).

Multigroup analyses were further conducted with and without measurement invariance across studies (sample 1 vs. sample 2), gender (boys vs. girls), and age groups (elementary school students vs. junior high school students). If measurement invariance between groups did not hold, further constrained analyses were conducted to examine the partial measurement invariance of item response prevalence for each latent class between groups. The likelihood ratio chi-square test ($G^2$) was used for evaluating models in multigroup and constrained analyses. A significant $G^2$ test in measurement invariance would indicate that the latent class structure differs between groups and latent structure should be interpreted separately by groups.

Results
Six-month prevalence rates of sleep problems

Table 2 presents the six-month prevalence rates of sleep problems in girls, boys, elementary school students, and junior high school students. PLMs was the most prevalent sleep problem for boys ($n = 347, 22.3\%$), girls ($n = 304, 20.3\%$), elementary school students ($n = 444, 25.1\%$), and junior high school students ($n = 149, 14.7\%$). According to the logistic regressions analyses, bruxism and snore were less common in girls compared to boys. Regarding age group differences, disturbed circadian rhythm was less common in elementary school students than in junior high school students, whereas sleep terror, sleepwalking, sleep-talking, nightmare, bruxism, snore, and periodic leg movements were more common in elementary school students (Table 2).
Latent class analysis and multigroup analysis

Model fit indices for latent class analysis are shown in Table 3. The four-latent-class model ($G^2 = 933.81$, $AIC = 1043.81$, $BIC = 1369.99$, and entropy = 0.84) was chosen based on its minimal BIC value.

We then examined measurement invariance between studies, gender, and age groups. The model fit information for four-latent-class multigroup analysis with all parameters freely estimated between two studies was $G^2 = 1090.42$ and $df = 16273$. The model fit information for four-latent-class multigroup analysis with measurement invariance across studies (sample 1 vs. sample 2) was $G^2 = 1142.18$, $df = 16325$. The likelihood ratio test indicated that the measurement invariance assumption held ($\Delta \chi^2(52) = 51.8; p = 0.4833$), which suggested that the latent classes among children did not differ between samples from two different studies. With regard to gender and age groups, the measurement invariance assumption did not hold between boys and girls ($\Delta \chi^2(52) = 96.1; p < 0.001$) and between elementary and junior high school students ($\Delta \chi^2(52) = 88.9; p < 0.001$), which suggested that the latent classes should be analyzed separately for gender and age groups. We, therefore, divided the participants into four groups: (a) elementary school boys, (b) elementary school girls, (c) junior high school boys, and (d) junior high school girls. A final likelihood ratio test was conducted and found the measurement invariance assumption did not hold ($\Delta \chi^2(156) = 206.4; p = 0.004$) across these four gender and age groups.

Moreover, the further constrained analyses indicated that the partial measurement invariance assumption for each latent class between gender and age groups did not hold either ($ps < 0.05$), which indicated that the item-response prevalence rates within classes differed between gender and age groups.

---

Table 2. Six-month prevalence rates of sleep problems in gender and age groups.

<table>
<thead>
<tr>
<th>Sleep problems</th>
<th>Boys (N = 1,554)</th>
<th>Girls (N = 1,498)</th>
<th>Statistics</th>
<th>Elementary school students (N = 1,894)</th>
<th>Junior high school students (N = 1,158)</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>OR (95% CI)</td>
<td>n</td>
<td>%</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>Early insomnia</td>
<td>75</td>
<td>4.8</td>
<td>1.11 (0.79–1.57)</td>
<td>98</td>
<td>5.5</td>
<td>0.76 (0.52–1.09)</td>
</tr>
<tr>
<td>Middle insomnia</td>
<td>40</td>
<td>2.6</td>
<td>1.33 (0.86–2.06)</td>
<td>59</td>
<td>3.3</td>
<td>0.77 (0.48–1.22)</td>
</tr>
<tr>
<td>Disturbed circadian rhythm</td>
<td>31</td>
<td>2.0</td>
<td>1.68 (0.54–5.70)</td>
<td>35</td>
<td>2.0</td>
<td>1.83 (1.14–2.93)*</td>
</tr>
<tr>
<td>Sleep terror</td>
<td>61</td>
<td>3.9</td>
<td>0.73 (0.48–1.11)</td>
<td>72</td>
<td>4.1</td>
<td>0.55 (0.34–0.88)*</td>
</tr>
<tr>
<td>Sleepwalking</td>
<td>37</td>
<td>2.4</td>
<td>1.05 (0.65–1.69)</td>
<td>53</td>
<td>3.0</td>
<td>0.52 (0.30–0.92)*</td>
</tr>
<tr>
<td>Sleep talking</td>
<td>224</td>
<td>14.4</td>
<td>0.89 (0.71–1.10)</td>
<td>263</td>
<td>14.9</td>
<td>0.74 (0.59–0.94)*</td>
</tr>
<tr>
<td>Nightmare</td>
<td>71</td>
<td>4.6</td>
<td>1.11 (0.78–1.56)</td>
<td>99</td>
<td>5.6</td>
<td>1.12 (0.77–1.62)</td>
</tr>
<tr>
<td>Bruxism</td>
<td>205</td>
<td>13.2</td>
<td>0.77 (0.61–0.97)*</td>
<td>240</td>
<td>13.6</td>
<td>0.62 (0.48–0.80)**</td>
</tr>
<tr>
<td>Snore</td>
<td>305</td>
<td>19.6</td>
<td>0.61 (0.50–0.75)**</td>
<td>312</td>
<td>17.6</td>
<td>0.76 (0.61–0.94)*</td>
</tr>
<tr>
<td>Sleep apnea</td>
<td>33</td>
<td>2.1</td>
<td>0.84 (0.49–1.45)</td>
<td>36</td>
<td>2.0</td>
<td>1.08 (0.63–1.88)</td>
</tr>
<tr>
<td>Periodic leg movements</td>
<td>347</td>
<td>22.3</td>
<td>0.89 (0.74–1.10)</td>
<td>444</td>
<td>25.1</td>
<td>1.08 (0.63–1.88)</td>
</tr>
<tr>
<td>Sleep paralysis</td>
<td>30</td>
<td>1.9</td>
<td>1.06 (0.62–1.80)</td>
<td>34</td>
<td>1.9</td>
<td>1.08 (0.63–1.88)</td>
</tr>
<tr>
<td>Narcolepsy</td>
<td>20</td>
<td>1.3</td>
<td>1.13 (0.60–2.11)</td>
<td>26</td>
<td>1.5</td>
<td>1.04 (0.49–1.81)</td>
</tr>
</tbody>
</table>

Note. Boys and elementary school students were the reference groups for logistic regression analyses. *p < .05; **p < .01; ***p < .001.

Table 3. Summary of information for selecting the number of latent classes for sleep problems from the basic model.

<table>
<thead>
<tr>
<th>No. of classes</th>
<th>G^2</th>
<th>AIC</th>
<th>BIC</th>
<th>Entropy</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3918.86</td>
<td>3944.86</td>
<td>4021.96</td>
<td>1.00</td>
<td>8178</td>
</tr>
<tr>
<td>2</td>
<td>1843.23</td>
<td>1897.23</td>
<td>2057.36</td>
<td>0.88</td>
<td>8164</td>
</tr>
<tr>
<td>3</td>
<td>1132.07</td>
<td>1214.07</td>
<td>1457.22</td>
<td>0.80</td>
<td>8150</td>
</tr>
<tr>
<td>4</td>
<td>933.81</td>
<td>1043.81</td>
<td>1369.99</td>
<td>0.84</td>
<td>8136</td>
</tr>
<tr>
<td>5</td>
<td>857.49</td>
<td>995.49</td>
<td>1404.70</td>
<td>0.77</td>
<td>8122</td>
</tr>
<tr>
<td>6</td>
<td>740.02</td>
<td>906.02</td>
<td>1398.26</td>
<td>0.82</td>
<td>8108</td>
</tr>
</tbody>
</table>

Note. AIC = Akaike information criterion, BIC = Bayesian information criterion, df = degrees of freedom

Latent class analysis and multigroup analysis

Model fit indices for latent class analysis are shown in Table 3. The four-latent-class model ($G^2 = 933.81$, $AIC = 1043.81$, $BIC = 1369.99$, and entropy = 0.84) was chosen based on its minimal BIC value.

We then examined measurement invariance between studies, gender, and age groups. The model fit information for four-latent-class multigroup analysis with all parameters freely estimated between two studies was $G^2 = 1090.42$ and $df = 16273$. The model fit information for four-latent-class multigroup analysis with measurement invariance across studies (sample 1 vs. sample 2) was $G^2 = 1142.18$, $df = 16325$. The likelihood ratio test indicated that the measurement invariance assumption held ($\Delta \chi^2(52) = 51.8; p = 0.4833$), which suggested that the latent classes among children did not differ between samples from two different studies. With regard to gender and age groups, the measurement invariance assumption did not hold between boys and girls ($\Delta \chi^2(52) = 96.1; p < 0.001$) and between elementary and junior high school students ($\Delta \chi^2(52) = 88.9; p < 0.001$), which suggested that the latent classes should be analyzed separately for gender and age groups. We, therefore, divided the participants into four groups: (a) elementary school boys, (b) elementary school girls, (c) junior high school boys, and (d) junior high school girls. A final likelihood ratio test was conducted and found the measurement invariance assumption did not hold ($\Delta \chi^2(156) = 206.4; p = 0.004$) across these four gender and age groups.

Moreover, the further constrained analyses indicated that the partial measurement invariance assumption for each latent class between gender and age groups did not hold either ($ps < 0.05$), which indicated that the item-response prevalence rates within classes differed between gender and age groups.
Figure 1. Graphical displays of item-response prevalence rates for various sleep problems across each of the four classes resulting from LCM. For class 1 (moderate to high sleep problems), there were 1.1% of elementary school boys, 1.4% of elementary school girls, 2.4% of junior high school boys, and 3.1% of junior high school girls. For class 2 (sleep related-breathing problems and parasomnias dominant), there were 21.1% of elementary school boys, 19.0% of elementary school girls, 16.6% of junior high school boys, and 14.9% of junior high school girls. For class 3 (insomnias dominant and parasomnias), there were 3.1% of elementary school boys, 1.1% of elementary school girls, 3.0% of junior high school boys, and 1.0% of junior high school girls. For class 4 (no or low sleep problems), there were 74.7% of elementary school boys, 78.5% of elementary school girls, 78.0% of junior high school boys, and 81.0% of junior high school girls.

**Item-response prevalence of sleep problems in gender and age groups**

Figure 1 displays the prevalence rates of sleep problems per class by groups. The item-response prevalence for the 13 sleep problems and the prevalence of four latent classes across gender and age groups is shown in Table 2. For class 1 (moderate to high sleep problems), there were 13 (1.1%) boys and 14 (1.4%) girls from...
elementary schools, and 14 (2.4%) boys and 17 (3.1%) girls from junior high schools. Participants in this class reported moderate to high rates in every sleep problem. Class 2 (sleep related-breathing problems and parasomnias dominant) consisted of 179 (21.1%) boys and 100 (19.0%) girls from elementary schools, and 100 (16.6%) boys and 83 (14.9%) girls from junior high schools. Participants who were in this class reported having high prevalence rates in PLMs, sleep talking, bruxism and snore. Class 3 (insomnias dominant and parasomnias) consisted of 29 (3.1%) boys and 10 (1.1%) girls from elementary schools, and 18 (3.0%) boys and 6 (1.0%) girls from junior high schools. Junior high school students and elementary school boys reported very high prevalence rates in insomnias, whereas elementary school girls demonstrated a very different pattern with high prevalence rates in bruxism, snore, and PLMs. Class 4 (no or low sleep problems) was the most common class, with 741 (74.7%) boys and 471 (78.5%) girls from elementary schools, and 471 (78.0%) boys and 449 (81.0%) girls from junior high schools. In contrast to the other classes, children in this class reported no sleep problems or relatively low sleep problems in general.

**Discussion**

The major contribution of this study to the current literature was the examination of the moderation effects of age and gender, not just on sleep problems, but also on the latent classes and subtypes of sleep problems in the general child population. The current literature implementing the person-oriented approach in sleep-related research is limited in terms of measurements and study populations. Most used measurements with combined items, including sleep problems (mostly dyssomnias), qualities, patterns, and durations. Thus, these past findings focused on either subtypes of sleep quality (Yildrim & Boysan, 2017; Leigh, Hudson, & Byles, 2015; Magee, Reddy, Robinson, & McGregor, 2016; Martin et al., 2013; Tavernier & Willoughby, 2014) or subtypes within certain sleep categories, such as dyssomnias (Foley, Sarsour, Kalsekar, & Walsh, 2010; Ownby, Peruyera, Acevedo, Loewenstein, & Sevus, 2014; Vallieres, Ivers, Beaulieu-Bonneau, & Morin, 2011; Wang et al., 2016; Williams, Nicholson, Walker, & Berthelsen, 2016) and obstructive sleep apnea (Joosten et al., 2012). Moreover, studies were primarily in adults or patients who have sleep disorders or other medical conditions with sleep complaints (Yildrim & Boysan, 2017; DeMartini & Fucito, 2014; Foley et al., 2010; Ownby et al., 2014). Unlike previous studies, the present study focused on the general child population and included a variety of sleep problems, including dyssomnias, parasomnias, and sleep related-breathing problems.

We identified four distinct patterns of sleep problems in children, with different prevalence rates and comorbid patterns across gender and age groups. The four-class model in sleep problems is the most common one within a range from two to five in the literature using the person-oriented approach (Yildrim & Boysan, 2017; Buysse et al., 2008; DeMartini & Fucito, 2014; Foley et al., 2010; Leigh et al., 2015; Magee et al., 2016; Martin et al., 2013; Ownby et al., 2014; Tavernier & Willoughby, 2014; Wang et al., 2016; Williams et al., 2016). Some classes (i.e., Class 1 “moderate to high sleep problems” and 4 “no or low sleep problems”) demonstrated similar patterns as previous studies, while other classes (i.e., class 2, sleep related-breathing problems and parasomnias dominant, and class 3, insomnias dominant and parasomnias) showed distinguished patterns that have not been reported.

Class 1 (moderate to high sleep problems, 1.1%–3.1%) and class 4 (no or low sleep problems, 74.7%–81.4%), which were on the opposite ends of the spectrum in terms of the prevalence rates, were supported in previous studies. These classes were “very poor” (4.0%) vs. “normative” (69.0%; Williams et al., 2016) and “troubled sleepers” (10.6%) vs. “normal sleeper” (89.4%; Wang et al., 2016) among children, “poor sleepers” (78.7%) vs. “good sleepers” (21.3%; Yildrim & Boysan, 2017) and “poor sleepers” (20.0%) vs. “good sleepers” (26.7%) among adults (Magee et al., 2016), “troubled sleepers” (22.7%) vs. “untroubled sleepers” (32.1%) among elderly women (Leigh et al., 2015), and “severe” (20.1%) vs. “normal” (47.7%) among patients with Alzheimer’s disease (Ownby et al., 2014). The former classes were characterized by high rates of frequent sleep disturbances, difficulty falling asleep, or poor self-perceived sleep quality, whereas the latter classes were described as high self-perceived sleep quality or a low frequency of sleep disturbances.
The proportions of good sleepers, class 4, low or no sleep problem, across gender and age groups in this youth sample, were consistently higher than poor sleepers, which is in line with most past studies (except for one adult study in which the poor sleeper was the majority; Yildrim & Boysan, 2017). The prevalence rate of poor sleepers was higher in older children (i.e., junior high school students) than younger children in our study. Some biological factors such as brain maturation, hormone and circadian system changes, as well as changes in daily routines, school demands, and responsivities during the transition from childhood to adolescence, might account for this age-specific effect in sleep (Barclay & Gregory, 2014). Moreover, the relatively low prevalence rate of poor sleepers in our child sample, compared to those with adult or elderly samples (Yildrim & Boysan, 2017; Leigh et al., 2015; Magee et al., 2016; Ownby et al., 2014), suggests possibly that sleep problems and the class of poor and troubled sleepers continue to increase with age during adulthood. This is consistent with previous research showing significant age effects on many sleep problems, such as insomnias (Kiejna, Wojtyniak, Rymaszewska, & Stokwiszewski, 2003), circadian rhythm disorders (Herman, 2014), snoring, and sleep apnea (Jennum & Sjøl, 1992).

Class 2 (sleep-related breathing problems and parasomnias dominant, 14.9%–21.1%) and 3 (insomnias dominant and parasomnias, 1.0%–3.1%) demonstrated the significant diversity and changes in parasomnias, dyssomnias, and their comorbid sleep problems with interaction across gender and age. Compared to class 2 with sleep related-breathing problems and parasomnias dominant that are consistent across groups, there was a significant variation of dyssomnias and parasomnias in class 3 across gender and age groups. Although not very obvious, the pattern of sleep problems was more diverse in girls than in boys, especially in dyssomnias. These findings have been supported by many previous studies (Calhoun, Fernandez-Mendoza, Vgontzas, Liao, & Bixler, 2014; Johnson, Roth, Schultz, & Breslau, 2006; Knutson, 2005).

The gender-specific puberty changes may be one possible explanation for the distinguished differences related to gender. It has been suggested that the onset of puberty is an important period when gender differences in sleep problems become apparent afterward (Krishnan & Collop, 2006). In addition, in class 3, early insomnia seemed to be more prevalent in older children (i.e., junior high school students). Cultural and environmental stress, in addition to biological factors, may play a role in explaining the age effects on insomnias within classes. For example, school environment and academic pressure might differ between cultures. Earlier school start time (usually before 7:30 a.m.; Owens, 2004) and higher academic stress (Ang et al., 2009) in Asian countries, compared to Western countries, may account for changes in sleep habits and increases in sleep problems (e.g., insomnia) in adolescents relative to younger children (Gau & Soong, 2003). Finally, the gender and age differences in sleep problems are better considered to be the combination of unique environmental, social and cultural, and psychological influences on biological factors (Jenni & O’Connor, 2005; Mallampalli & Carter, 2014).

Our results represent a good example to demonstrate the differences between person-oriented and variable-oriented approaches in that a person-oriented approach better reflects the characteristics of individuals, whereas a variable-oriented approach better reflects the average level across individuals. For example, using a variable-oriented approach (i.e., logistic regression), we found that most sleep problems, except for snore and bruxism, did not significantly differ between boys and girls. However, results based on the person-oriented approach (i.e., LCM) showed that the prevalence of sleep problems within classes significantly varied across gender. On the other hand, although we found that many sleep problems were more common in elementary school students than in junior high students based on logistic regressions, early insomnias in class 2 and 3 were higher in junior high students.

**Implications and future directions**

The high concurrence of parasomnias with sleep related-breathing problems (class 2) and with insomnias (class 3) suggests that the underlying mechanisms for these two classes may be different. Future studies should validate these classes and extend the investigation to clinical samples. The
person-oriented perspective has important implications not only for research but also for clinical practice. The person-oriented and personalized medicine, which emphasizes the heterogeneity of patients, diseases, and individually tailored treatment options to improve outcomes and reduce adverse events, are common in neurology (Lisak, Demarin, Trkanjec, Zavoreo, & Bašić Kes, 2014) and psychosocial oncology (Watson, Dunn, & Holland, 2014). Our study demonstrates the diverse manifestations of co-occurring sleep problems and associated age and gender effects. The nature of high diversity and co-occurrence of sleep problems as well as age- and gender-specific patterns through childhood and adolescence suggest that clinicians should take the heterogeneity and comorbidities into account while assessing and treating sleep problems.

**Limitations**

Several limitations of our work are worth mentioning. First, the measurement of sleep problems was based on parental reports in a cross-sectional study design. Measurement agreement in sleep problems between self-reports and objective measure (i.e., actigraphy; Girschik, Fritschi, Heyworth, & Waters, 2012), as well as between child’s and parent’s reports (Owens, Maxim, Nobile, McGuinn, & Msall, 2000), is not high. Parents might not be aware of the sleep problems that their child has, especially for older children and adolescents. Thus, the age effect found in our cross-sectional study may be confounded by this. Another problem with a cross-sectional design is the generation effects (cohort effects), that is, a source of variation characterizing the participants born at a certain time, but not from age effects (Baltes, 1968). To address these issue, future research with data from clinical interviews, objective measures (e.g., polysomnography or actigraphy), and self-reports are needed to replicate our findings. The developmental courses for different classes should be better clarified in future longitudinal research. Second, aside from age and gender, this study did not examine other psychological or physiological characteristics associated with different classes of sleep problems because we used two different samples and there were few common variables across the two samples. It is important to be aware that the covariates can influence the size and characteristics of the latent classes. This would be another direction for future research, as studies have demonstrated that physical function, marital status, overweight, living environment, and depression symptoms significantly differed among subtypes of sleep problems (Leigh et al., 2015; Ownby et al., 2014). Third, we used categorical variables in our analyses; results may differ from analyses that use a mix of continuous and categorical variables. Finally, the “moderate to high sleep problems” class is small. The reliability and validity of this class in children may be questionable.

**Conclusion**

This is the first large-scale study to examine the patterns of sleep problems across gender and age groups using a person-oriented approach with multigroup analysis. Our results identified four classes of sleep problems across genders (boys vs. girls) and age groups (elementary school students vs. junior high school students). Future studies are warranted to replicate these classes. Moreover, our results indicated that the comorbidity between sleep problems might be gender- and age-specific. Gender and developmental considerations should be included in examination, interpretation, and treatment of the subtypes of sleep problems. Finally, another question worth exploring is whether classes that show a high prevalence in common sleep problems share similar or different underlying mechanisms.

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References


