One-Year Course and Effects of Insomnia in Rural Chinese Adolescents

Chunliu Luo, RN, MSc1,2; Jihui Zhang, MD, PhD1,3,4; Jiyang Pan, MD1

1Department of Psychiatry, The First Affiliated Hospital, Jinan University, Guangzhou, Guangdong, China; 2Department of Nursing, The First Affiliated Hospital, Jinan University, Guangzhou, Guangdong, China; 3Genetic Epidemiology Branch, Intramural Research Program, National Institute of Mental Health, National Institutes of Health, Department of Health and Human Services, Bethesda, MD; 4Department of Psychiatry, The Chinese University of Hong Kong, Shatin, Hong Kong SAR, China

Study Objectives: We aimed to explore the incidence and persistence of insomnia, the associated risk factors, and the potential bidirectional association of insomnia with depression, anxiety, and sleepiness in rural Chinese adolescents.

Design: School-based prospective study.

Setting: Five high schools in rural China.

Participants: There were 2,787 adolescents studied.

Interventions: N/A.

Measures and Results: Insomnia was defined as having a score of equal to or higher than nine in the Insomnia Severity Index as validated in Chinese adolescents. Depression, anxiety, and sleepiness were determined by the Beck Depression Inventory (BDI), Zung Self-Rating Anxiety Scale (SAS), and Epworth Sleepiness Scale (ESS), respectively. The incidence and persistence rates of insomnia were 16.0% and 41.0%, respectively. Multivariate analyses in logistic regression models revealed that new incidence of insomnia was significantly associated with age, living in a rural area, habitual daytime napping, high life events, anxiety, and depression at baseline (range adjusted odds ratio = 1.12-1.61), whereas the persistence of insomnia was positively associated with age, female sex, high life events, and depression at baseline (range adjusted odds ratio = 1.26-1.55) but negatively associated with living in a rural area (odds ratio = 0.59). Insomnia at baseline could predict new onsets of both depression (odds ratio = 1.45) and anxiety (odds ratio = 1.98) but not sleepiness at follow-up after adjustment for age, sex, and baseline symptoms. The results in cross-lagged analyses further supported these observations in the bidirectional associations of insomnia with depression, anxiety, and sleepiness.

Conclusions: Insomnia has considerable incidence and persistence rates in Chinese adolescents. We have identified several risk factors for the incidence and persistence of insomnia. There are bidirectional associations of insomnia with depression and anxiety but not sleepiness.

Keywords: Anxiety, depression, insomnia, longitudinal course, sleepiness

Citation: Luo C; Zhang J; Pan J. One-year course and effects of insomnia in rural Chinese adolescents. SLEEP 2013;36(3):377-384.

INTRODUCTION

There is an increasing body of studies showing that insomnia is a common problem with significant burdens on both mental and physical health in Chinese adolescents.1-10 These studies, nearly all with cross-sectional design, have also identified several risk factors of insomnia in adolescents, such as older age, sex, comorbid mental disorders, and living in an urban area.1,4,6-10 However, these conclusions are limited by the cross-sectional design by which the researchers could not estimate the effects of these risk factors on the course of insomnia and the temporal associations between insomnia and comorbid mental disorders. Indeed, Roberts et al.11 have reported that the robust associations between insomnia and psychological functioning, which are commonly found in cross-sectional studies, dramatically attenuate in a prospective study in U.S. adolescents. In addition, previous studies have demonstrated that the female predominance of insomnia in middle-aged Chinese adults is mainly accounted for by the higher persistence rate rather than higher incidence rate in females.12 In this regard, longitudinal studies are warranted to identify the potentially different effects of these risk factors on the incidence and persistence of insomnia in adolescents and subsequently provide specific strategies of prevention and intervention for those adolescents at risk.

A series of longitudinal studies from developed countries or regions has demonstrated that insomnia is a relatively stable problem across time in adolescents with an estimated persistence rate of 15-60% according to different definitions and different periods of follow-up.7,11,15-18 In addition, insomnia at baseline predicts future behavioral problems and mental distress in adolescents.7,17,19,20 However, the findings of longitudinal studies in other populations might not be applicable to adolescents in China because previous studies have shown that there are significant cross-cultural differences in sleep patterns and sleep problems in children and adolescents.10,21 Liu et al.21 have reported that school-aged children in China present with more sleep problems, shorter sleep duration, and later bedtime than their US peers.21 These cross-cultural differences exist even within Chinese adolescents from different regions. Our previous study has shown that Cantonese adolescents from Guangdong province have more insomnia symptoms, shorter sleep duration, and more daytime napping, but earlier bedtime and less sleepiness than Cantonese adolescents from Macau, a former Portuguese colony bordering Guangdong province.10 The cross-cultural differences as found in previous studies suggest that the longitudinal course of insomnia should be specifically addressed in adolescents from...
mainland China. The current study aimed to explore the longitudinal course of insomnia in adolescents recruited from rural and suburban areas. In addition, we also investigated the risk factors associated with the incidence and persistence of insomnia and the long-term effects of insomnia on mental distresses, including depression, anxiety, and sleepiness.

METHODS

Participant Selection
The current study is the major analysis of a school-based cohort study that aimed to explore the longitudinal changes and predictors of sleep patterns, insomnia, and mental distresses in high-school adolescents in Longmen County, Guangdong Province, China. The baseline study was conducted in October 2010 and the follow-up study was conducted in October 2011. At the time of baseline, there were 22 high schools and approximately 18,600 students in Longmen County. The targeted sample size was 5,000 to 6,000 to establish the prevalence and correlates of several sleep problems. A total of eight high schools were randomly invited and five high schools accepted our invitation through the presidents of these school. These five high schools consisted of 99 classes and 5,003 adolescents age 11 to 18 years. This sample accounted for 26.9% of all high-school adolescents from Longmen County, Guangdong Province. With the assistance of the teachers the questionnaires were distributed to the adolescents, who were instructed by our research staff to complete the questionnaires within 1 wk. At baseline, 4,800 of 5,003 adolescents responded, which conferred a response rate of 95.9%. This response rate at baseline was comparable to those school-based sleep studies from other areas in mainland China. Due to the fact that those students in grade 9 and grade 12 left school at follow-up period and most of them could not be contacted, we only targeted those adolescents in grades 7, 8, 10, and 11. A total of 3,736 of the 4,800 adolescents with valid responses at baseline, and in grades 7, 8, 10, and 11 were eligible for follow-up study. Among them, 2,787 (74.6%) had a valid response at follow-up.

Measures

Socio-demographics and Lifestyle (Baseline)
Basic socio-demographics were measured by several binary or ordinal questions, such as parental education level (≤ 9 years or > 9 years), family income (< 2,000 yuan/mo or ≥ 2,000 yuan/mo), boarding in school during school days (yes or no), and living in a rural area or suburban area. Age and sex were also reported by the participants.

Lifestyle Practice (Baseline)
Smoking behavior was assessed with the following question: Have you ever smoked (yes or no)? Bedtime and wakeup time were measured with the following questions: When do you usually go to bed? and When do usually you get up in the morning? The sleep patterns during weekdays and weekends were assessed separately. Time in bed (TIB) was calculated as the period between bedtime and wakeup time. The average bedtime and TIB were calculated as a weighted average of weekday and weekend: (1) average bedtime = (weekday bedtime × 5 + weekend bedtime × 2) / 7; (2) average TIB = (weekday TIB × 5 + weekend TIB × 2) / 7. Those adolescents with an average TIB less than or 8.5 h were considered short sleepers according to the recommendation for teenagers (age 10-17 years) from the National Sleep Foundation. Because there is a lack of consensus about cutoff for bedtime, adolescents with an average bedtime later than 11:00 were considered late sleepers, which accounted for approximate 15% of the total valid sample. Habitual afternoon napping was defined as having an afternoon nap at least 3 days/wk. Perceived study stress and study interest were also measured by binary questions.

Insomnia Assessment (Both Waves)
Insomnia was assessed by the Insomnia Severity Index (ISI). The ISI is a seven-item questionnaire assessing the subtype, severity, and effect of sleep difficulties over the past 2 wk. The cutoff scores as suggested by the original validation study were not used in the current study because a recent study found that a score ≥ 9 in ISI was optimal to determine insomnia diagnosis in Chinese adolescents.

Depression (Both Waves)
Depression was measured by the Beck Depression Inventory (BDI), which consists of 21 items on a four-point scale to measure the intensity of depression. The total score, ranging from 0 to 63, was obtained by summing the ratings on each item. A total score of at least 20 with the BDI was indicative of depression in the Chinese population, and was adopted in the current study.

Anxiety (Both Waves)
Anxiety symptoms were measured by the Zung Self-Rating Anxiety Scale (SAS), which consists of 20 items on a four-point scale with a maximum score of 80. Those adolescents with a SAS score of at least 40 were considered to have anxiety according to the validation study in the Chinese population.

Sleepiness (Both Waves)
Sleepiness was measured by a widely used scale, the Epworth Sleepiness Scale (ESS). The Chinese version of the ESS had been demonstrated to have satisfactory psychometric properties. Patients with a total score higher than 10 were considered to have sleepiness.

Life Events Assessment for Adolescents (Baseline)
Adolescent Self-Rating Life Events Checklist (ASLEC) was used to assess the life events during the past 12 mo at baseline. ASLEC contains 27 items measuring six domains of negative life events in adolescents including interpersonal relationship, academic stress, family conflict, and health with adequate test-retest reliability and criterion-related validity. The total score of ASLEC ranges from 0 to 108. Because there was a lack of cutoff point for ASLEC, adolescents with the highest quartile of ASLEC (> 45) in this cohort were considered to have a high stress level.

Statistical Methods
Descriptive statistics were presented as percentages for discrete variables and as means (standard deviation) for continuous variables. The differences in the sample characteristics
between responded adolescents and those who dropped out of the study were tested by independent t-test or chi-square test to explore the potential sample attrition (Table 1).

**Course of Insomnia and Its Predictors**

All predictors for the course of insomnia were extracted from baseline data. The participants were first divided into two groups according to whether they had insomnia at baseline (Tables 2 and 3). For those without insomnia at baseline (n = 2,129), they were further classified into a persistent good sleep group and an incident insomnia group on the basis of the insomnia status at follow-up (Table 2). For those adolescents with insomnia at baseline (n = 658), they were further classified into a remitted group or a persistent group on the basis of the insomnia status at follow-up (Table 2).

---

**Table 1**—Sociodemographic characteristics of the cohort at both baseline and follow-up

<table>
<thead>
<tr>
<th></th>
<th>Nonresponders (n = 949)</th>
<th>Responders (n = 2,787)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, year</strong></td>
<td>15.3 (1.6)</td>
<td>15.0 (1.5)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td><strong>Sex, male n (%)</strong></td>
<td>451 (48.0)</td>
<td>1,362 (48.9)</td>
<td>0.636</td>
</tr>
<tr>
<td><strong>Paternal education level (senior high school or above), n (%)</strong></td>
<td>181 (19.3)</td>
<td>502 (18.0)</td>
<td>0.394</td>
</tr>
<tr>
<td><strong>Maternal education level (senior high school or above), n (%)</strong></td>
<td>134 (14.3)</td>
<td>348 (12.5)</td>
<td>0.162</td>
</tr>
<tr>
<td><strong>Family income (2,000 yuan/mo or above), n (%)</strong></td>
<td>206 (21.9)</td>
<td>609 (21.9)</td>
<td>0.968</td>
</tr>
<tr>
<td><strong>Living in school during school days, n (%)</strong></td>
<td>282 (30.0)</td>
<td>876 (31.4)</td>
<td>0.412</td>
</tr>
<tr>
<td><strong>Rural area, n (%)</strong></td>
<td>820 (87.2)</td>
<td>2,377 (85.3)</td>
<td>0.140</td>
</tr>
<tr>
<td><strong>High perceived study stress, n (%)</strong></td>
<td>99 (14.0)</td>
<td>289 (10.4)</td>
<td>0.002*</td>
</tr>
<tr>
<td><strong>Low perceived study interest, n (%)</strong></td>
<td>99 (10.5)</td>
<td>170 (6.1)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td><strong>Smoking, n (%)</strong></td>
<td>34 (3.6)</td>
<td>63 (2.3)</td>
<td>0.024*</td>
</tr>
<tr>
<td><strong>Poor health condition, n (%)</strong></td>
<td>33 (3.5)</td>
<td>75 (2.7)</td>
<td>0.195</td>
</tr>
<tr>
<td><strong>Insomnia at baseline, n (%)</strong></td>
<td>262 (28.5)</td>
<td>658 (23.6)</td>
<td>0.009*</td>
</tr>
</tbody>
</table>

*One yuan equals 0.16 US dollar. °P < 0.05. °P < 0.01. SD, standard deviation.

---

**Table 2**—Baseline factors associated with incidence of insomnia

<table>
<thead>
<tr>
<th></th>
<th>N (%)</th>
<th>Crude OR (95% CI)</th>
<th>Logistic regression model OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sociodemographics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Age, year</strong></td>
<td>NA</td>
<td>1.14 (1.05-1.24)</td>
<td>1.12 (1.03-1.22)</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>1,055 (49.6)</td>
<td>1.13 (0.90-1.43)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Paternal education level (≤ 9 years)</strong></td>
<td>1,727 (81.1)</td>
<td>1.28 (0.94-1.76)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Maternal education level (≤ 9 years)</strong></td>
<td>1,852 (87.0)</td>
<td>1.23 (0.86-1.77)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Family income (2,000 yuan/mo or higher)</strong></td>
<td>1,634 (76.7)</td>
<td>1.07 (0.81-1.41)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Rural area</strong></td>
<td>1,800 (84.5)</td>
<td>1.55 (1.08-2.22)</td>
<td>1.58 (1.10-2.27)</td>
</tr>
<tr>
<td><strong>Life style and health condition</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Boarding in school during school days</strong></td>
<td>605 (28.4)</td>
<td>1.37 (1.07-1.75)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Smoking</strong></td>
<td>42 (2.0)</td>
<td>1.15 (0.48-2.74)</td>
<td>–</td>
</tr>
<tr>
<td><strong>High perceived study stress</strong></td>
<td>195 (9.2)</td>
<td>1.55 (1.08-2.23)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Low perceived study interest</strong></td>
<td>115 (5.4)</td>
<td>0.91 (0.53-1.54)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Poor health condition</strong></td>
<td>51 (2.4)</td>
<td>1.13 (0.54-2.34)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Short time in bed (≤ 8.5 h)</strong></td>
<td>734 (33.6)</td>
<td>1.31 (1.04-1.66)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Late bedtime (later than 23:00)</strong></td>
<td>218 (10.2)</td>
<td>1.23 (0.86-1.77)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Habitual afternoon napping</strong></td>
<td>554 (26.0)</td>
<td>1.44 (1.12-1.85)</td>
<td>1.33 (1.02-1.72)</td>
</tr>
<tr>
<td><strong>Mood and mental distress</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>High Life events score</strong></td>
<td>415 (19.5)</td>
<td>1.74 (1.33-2.27)</td>
<td>1.53 (1.16-2.02)</td>
</tr>
<tr>
<td><strong>Anxiety</strong></td>
<td>296 (13.9)</td>
<td>1.96 (1.46-2.62)</td>
<td>1.61 (1.18-2.21)</td>
</tr>
<tr>
<td><strong>Depression</strong></td>
<td>207 (9.7)</td>
<td>1.90 (1.35-2.66)</td>
<td>1.50 (1.04-2.15)</td>
</tr>
<tr>
<td><strong>Excessive daytime sleepiness</strong></td>
<td>146 (6.9)</td>
<td>1.09 (0.70-1.70)</td>
<td>–</td>
</tr>
</tbody>
</table>

*Those variables with statistically significant association with insomnia were further tested by logistic regression analysis with forward likelihood method. Frequency and percentage of positive cases for the variables on the left. °One yuan equals 0.16 US dollar. °P < 0.05. °P < 0.01. °P < 0.001. Cells with no data (–) could not be recruited into the final model. CI, confidence interval; OR, odds ratio.
of the insomnia status at follow-up (Table 3). The associations of the courses of insomnia (incidence versus persistent good sleep and persistence versus remission) with regard to the socio-demographics, lifestyle practice, and mental distresses were first analyzed by chi-square test (crude model). To control for the potential confounding effects among these variables, those variables with statistically significant associations with the course of insomnia were further tested by multivariate logistic regression model using the forward likelihood method.

Long-Term Effects of Insomnia at Baseline on Mental Distresses

In the current study, the new incidences of depression, anxiety, and sleepiness at follow-up were considered to be longitudinal outcomes of baseline insomnia (Table 4). The chi-square statistic was used to analyze the associations between baseline insomnia and the new incidences of mental distresses. Multivariate logistic regression model (enter method) was used to explore these associations after adjustment for age, sex, and individual score at baseline. For example, when the new incidence of anxiety at follow-up was considered as outcome (dependent variable), age, sex, insomnia at baseline, and SAS total score at baseline were recruited into logistic regression model (enter method) as independent variables to predict anxiety at follow-up. In addition, cross-lagged associations were also constructed to assess the longitudinal associations of ISI score with SAS score, BDI score, and ESS score, respectively. For example, ISI score at baseline was used to predict SAS score at follow-up,
RESULTS

Sample Characteristics

Table 1 shows the sample characteristics in the current study. Among those participants eligible for follow-up, those individuals were slightly older (15.3 ± 1.6 years versus 15.0 ± 1.5 years) and had higher perceived study stress (14.0% versus 10.4%), less perceived study interest (10.5% versus 6.1%), higher rate of smoking behavior (3.6% versus 2.3%), and more insomnia at baseline (28.5% versus 23.6%) when compared with responders (P < 0.05). No differences were found in other demographic characteristics between responders and nonresponders. Among those recruited into follow-up study, more than 85% of the adolescents were from rural areas and the rest were from suburban areas.

One-Year Course of Insomnia

Figure 1 shows the one-year course of insomnia in this cohort. Among the responders without insomnia at baseline (n = 2,129), 16.0% of them developed insomnia. Among those responders with insomnia at baseline (n = 658), 270 of them persisted to have insomnia one year later, which conferred a persistence rate of 41.0% and a remission rate of 59.0%.

Correlated Factors Associated With Course of Insomnia

Table 2 presents the baseline correlates that might be associated with the incidence of insomnia. A total of 2,129 adolescents without insomnia at baseline were included in these analyses. In the univariate analyses, the new incidence of insomnia was associated with increased age, living in a rural area, boarding in school during weekdays, high study stress, short nocturnal TIB, habitual afternoon napping, high life events score, anxiety, and depression. The multivariate analysis in a logistic regression model revealed that the associations of incidence of insomnia with age, high life events score, living in a rural area, habitual afternoon napping, anxiety, and depression maintained statistical significance (range adjusted odds ratio = 1.12-1.61). The associations of the incidence of insomnia with boarding in school during school days, short nocturnal TIB, late bedtime, sleepiness, and health condition were associated with neither the incidence nor the persistence of insomnia in the final models.

The Incidences of Mental Distresses at Follow-Up in Participants with Insomnia at Baseline

Table 4 presents the associations of baseline insomnia and incidence of mental distresses, including depression, anxiety, and sleepiness at follow-up. Univariate analyses revealed that adolescents with insomnia at baseline had significantly higher rates of incident depression, incident anxiety, and incident sleepiness when compared with those adolescents without insomnia at baseline (range, odds ratio 1.90-2.28). These associations of insomnia with incident anxiety and incident depression maintained statistical significance after controlling for age, sex, and individual score at baseline but the strengths of associations attenuated accordingly. However, incident sleepiness at follow-up was not associated with insomnia at baseline in the adjusted model.

Cross-Lagged Associations of ISI with Other Mental Distresses

Figure 2 shows the results in cross-lagged analyses for the longitudinal associations of ISI with SAS, BDI, and ESS between baseline and follow-up, which demonstrated two important aspects: (1) ISI score at baseline predicted SAS and BDI scores but not ESS score at follow-up; (2) both SAS and BDI score but not ESS score at baseline predicted ISI score at follow-up. These results were consistent with findings in Tables 2 through 4.

DISCUSSION

To the best of our knowledge, this is the first study that reports the longitudinal course of insomnia in a Chinese adolescent population from mainland China. We have found that insomnia is a common sleep problem with a considerable persistence rate in Chinese adolescents mainly recruited from rural areas. In addition, several risk factors have been identified to be responsible for the persistence and incidence of insomnia in this population, which might have great implications for specific interventional strategies. The bidirectional associations between insomnia and anxiety and depression argue for the stringent use of active interventions for both insomnia and mental distresses.

Longitudinal Course of Insomnia in Adolescents

The persistence rate of insomnia as estimated in the current study (41%) is in the middle of those rates reported in other de-
Risk Factors for the Incidence and Persistence of Insomnia

Several findings for the risk factors are worthy of noting in the current study. First, SES is not likely to be associated with the course of insomnia, which is inconsistent with those findings reported in Hong Kong Chinese adolescents. In keeping with those findings in Chinese and Canadian adolescents, we found that females are more likely to have persistent insomnia but have comparable incidence of insomnia when compared with males. Hence, these findings suggest that high persistence rather than high incidence accounts for the female predominance in the prevalence of insomnia. The mechanisms underlying higher persistence rate of insomnia in females are unclear. Depression and anxiety have been suggested to be two putative factors for sex differences in prevalence of insomnia in a meta-analysis based on cross-sectional studies. Nevertheless, the current study suggests that the female predominance in persistence of insomnia is not likely to be mediated by higher depression and anxiety in females, as the association between persistence of insomnia and female sex is independent of these two variables.

Second, a previous cross-sectional study has suggested that Chinese adolescents living in rural areas have fewer sleep problems than those living in urban areas. However, the relationship between rural area and insomnia might differ in different contexts. Our study indicates that adolescents living in a rural area are at a higher risk of developing insomnia, but insomnia in those adolescents living in a rural area is less likely to persist across time.

Third, napping is a very common practice in the Chinese population. Although napping is considered as a self-help behavior to alleviate daytime sleepiness, recent studies have demonstrated that habitual afternoon napping is associated with adverse medical outcomes among the elderly, including type 2 diabetes and cardiovascular disease-related mortality. In addition to medical conditions, our study further shows that adolescents who engage in habitual afternoon napping are at a higher risk of developing insomnia. In this regard, more studies are warranted to comprehensively evaluate the advantages and disadvantages of daytime napping.

Finally, negative life events have long been proposed as a predisposing factor of the development of insomnia. Our findings support this hypothetical model for the evolution of insomnia. In addition to predisposing the new incidence of insomnia, high life events also perpetuate the chronicity of insomnia as suggested by our findings. Hence, reducing life events might be a strategy for both prevention and treatment of insomnia.

Bidirectional Associations between Insomnia and Anxiety and Depression

Cross-sectional studies have demonstrated that insomnia is highly comorbid with both anxiety and depression in the general population. Recent studies with prospective design have confirmed the long-term effects of insomnia on the onsets of both depression and anxiety. However, as pointed out by Staner, very few studies have investigated whether depression could predispose the new incidence or persistence of insomnia. To answer this question, the current study has nicely demonstrated that not only insomnia at baseline predicts future depression and anxiety, but depression and anxiety at baseline

---

Figure 2—(A) Cross-lagged association between ISI score and SAS score. (B) Cross-lagged association between ISI score and BDI score. (C) Cross-lagged association between ISI score and ESS score. Longitudinal associations (correlations) at baseline and follow-up expressed by standardized β coefficients. ***P < 0.001. Single-head arrows indicate direct paths (variables pointed by arrows are dependent variables) and double-head arrows indicate correlations. Solid lines represent statistically significant associations; dashed lines represent insignificant associations.

---

developed countries (21-60%) but is significantly higher than the rate of 15% reported in Hong Kong Chinese adolescents. Several reasons might contribute to the inconsistent findings in the course of insomnia across studies. First, the criteria for determination of insomnia are different between these two studies. The current study used a commonly used questionnaire, ISI, to define insomnia over the past 2 wk whereas previous studies adopted insomnia symptoms or insomnia symptom plus daytime function impairments over the past mo or past 12 mo. Second, there might be cultural differences between these two populations. By using the same measure, our previous study and Liu et al. have previously reported that there are cultural differences in sleep problems in the pediatric population. Finally, the follow-up periods in previous studies varied from one to five years. Because the transition from childhood to adolescence is a critical period for development of sleep behavior and sleep problems, the differences in follow-up period might have a great effect on the course estimate of insomnia. In view of the heterogeneities in methodology, criteria for determining insomnia, and period of follow-up across different studies, caution should be exercised when comparing the course of insomnia across different populations. In addition, the cross-cultural differences in sleep behavior and sleep problems found in cross-sectional studies should also be examined in future studies by using the same measurement and follow-up period.
are also associated with both incidence and persistence of insomnia. These findings suggest that there are bidirectional associations of insomnia with depression and anxiety. Although the mechanisms underlying the comorbidity and bidirectional associations between insomnia and depression and anxiety are unclear, Staner has proposed several pathways potentially mediating these complex relationships. Further studies with detailed measures on these key components, including neurobiologic assessments, homeostatic dysregulation, and emotional and physical hyperarousal, are warranted to address these issues.

Although a series of risk factors of insomnia have been investigated in the current study, several risk factors were not measured and should be included in future studies. For example, family history has been consistently found to be associated with the onset of insomnia in the adult population. In view of the strong familial aggregation and robust heritability of adolescent insomnia, further studies are warranted to investigate the role of family history in the evolution of insomnia.

**Limitations**

The major strength in the current study is the prospective design with assessments on a series of variables, including insomnia symptoms, depression, anxiety, sleepiness, and life events, which allows us to explore the potential bidirectional associations between insomnia and mental health outcomes. However, one should be cautioned about several limitations when interpreting our findings. First, due to graduation, the last-year students were not contactable and hence were not targeted. It remains unknown whether those last-year students differ from those responders in the features of longitudinal course of insomnia. Indeed, our finding has shown that age is a significant predictor for the new incidence and persistence of course of insomnia. Indeed, our finding has shown that age is a significant predictor for the new incidence and persistence of course of insomnia. Second, although the response rate is satisfactory, there are differences in some key variables of sample characteristics between responders and nonresponders, which indicate potential attritions in the current study. Third, the participants are students in high schools from rural and suburban areas and hence the conclusions generated from this study should not be necessarily applicable to those students in urban areas and those adolescents out of school. Fourth, all measures rely on self-reported questionnaires rather than diagnostic interview or objective assessments, which might lead to reporting bias. The cutoffs for BDI and ESS were not specifically validated in Chinese adolescents, which might also have biased the results when using binary analyses. Nonetheless, the findings in cross-lagged analyses were consistent with those in logistic regression models. In addition, some items in ESS as used in the current study might not be applicable to adolescents. Hence, one should be cautioned to interpret our findings that there is not directional association between insomnia and sleepiness in adolescents.

**CONCLUSIONS**

Insomnia is a common problem with considerable incidence and persistence rates in high-school adolescents living in rural China. SES exerts minimal effects on insomnia in adolescents from underdeveloped areas. The significant long-term effects of insomnia on anxiety and depression argue for active prevention and intervention for insomnia in adolescents. The risk factors for the incidence and persistence of insomnia as identified in the current study have great implications for prevention and intervention strategies. There are bidirectional associations of insomnia with depression and anxiety but not sleepiness.

**ACKNOWLEDGMENTS**

This study was funded by the Guangdong Provincial Medical Research Fund (A2010340). The authors would like to express their gratitude to the teachers and students for their kind participation and coordination in this study.

**DISCLOSURE STATEMENT**

This study was funded by the Guangdong Provincial Medical Research Fund (A2010340). The funder had no role in the design, data collection and analyses, and interpretation of findings. The authors report no conflicts of interest to disclose in terms of funding, employment, or personal financial interests. The views and opinions expressed in the report are those of the authors and should not be construed to represent the views of any of the sponsoring organizations or agencies.

**REFERENCES**

7. Zhang JH, Lam SP, Li SX, Li AM, Lai KYC, Wing YK. Longitudinal Course and Outcome of Chronic Insomnia in Hong Kong Chinese Children: A 5-Year Follow-Up Study of a Community-Based Cohort. Sleep 2011;34:1395-402.