Screening for Adult Attention-Deficit Hyperactivity Disorder in the Korean Community Sample: Prevalence and Association with Mood and Sleep Symptoms

ABSTRACT

Objective: Attention-deficit hyperactivity disorder (ADHD) symptoms start in early childhood and continue into adulthood, and are frequently associated with comorbid symptoms of depression, bipolar, insomnia, and daytime sleepiness. The aim of this study was to screen adult ADHD symptoms in a community sample and investigate the association of adult ADHD symptoms with mood and sleep symptoms.

Methods: Respondents (n = 1500) from the general adult population, aged between 19 and 49 years, were recruited. The sample consisted of a population in Busan, Korea that was representative in terms of sex, age, and residential area. ADHD symptoms and mood/sleep symptoms were assessed using validated questionnaires with cut-off threshold.

Results: The screening for adult ADHD documented ADHD symptoms in 3% (45 out of 1500) of the participants. The ADHD screen-positive group was more likely to have depression symptoms (OR = 14.97, 95% CI: 7.94-28.25, P < .001) and daytime sleepiness symptoms (OR = 3.18, 95% CI: 1.55-6.52, P < .001).

Conclusion: Present result indicates high prevalence of adult ADHD symptoms in a community sample in Korea. The findings of this study also suggest significant association between adult ADHD symptoms and depression symptoms and daytime sleepiness. Optimal management of adult ADHD requires the consideration of not only ADHD symptoms but also the assessment and treatment of symptoms associated with comorbid conditions.

Keywords: Attention deficit hyperactivity disorder, depression, bipolar disorder, insomnia, sleepiness

Introduction

Attention-deficit hyperactivity disorder (ADHD) has been traditionally recognized as a childhood disorder, but ADHD symptoms are not limited to childhood. Approximately 15-50% of children diagnosed with ADHD continue to have symptoms as adults, with the rate of persistence as high as 65%. In a large-scale epidemiological study conducted with adults from 20 countries, average adult ADHD prevalence was estimated at 2.8%.

According to the results of a previous study, 80% of adults with ADHD have at least one comorbid mental disorder. In particular, mood and sleep symptoms are commonly associated with adult ADHD. Comorbid mood problems such as depression and bipolar disorder lead to more severe functional impairments, which in turn require an increased level of intervention and treatment. Sleep problems are known to affect cognitive functions such as attention, learning, memory, impulse control, and executive function in ADHD.

While a number of previous studies have investigated the association between adult ADHD and both mood and sleep problems, no consensus has yet been reached. In addition, the majority of previous studies have been carried out on clinical samples, and not the general public. Only limited number of studies have utilized community samples. Therefore, the
objective of this study was to screen for adult ADHD symptoms in a Korean community sample and investigate the association of adult ADHD with mood and sleep problems.

Methods

Participants
A cross-sectional, self-administered survey was conducted in the metropolitan city of Busan, Korea. Respondents (n = 1500) from the general adult population, aged between 19 and 49 years, were recruited. The sample consisted of a population in Busan, Korea that was representative in terms of sex, age, and residential area. Participants were initially invited by telephone contact. Person who agreed to participate in this study were asked to fill in a study questionnaire in a face-to-face manner. Trained research assistants were sent to interview and assist the participant to understand and complete the questionnaire. Informed consent was obtained from all of the participants included in the study. The research was approved by the Institutional Review Board of Dong-A University Hospital (DAU-18-227) on November 22, 2018.

Assessments

Korean Version of the World Health Organization Adult ADHD Self-Report Scale: The presence of adult ADHD symptoms was assessed with the Korean version of the World Health Organization Adult ADHD Self-Report Scale (K-ASRS). It is based on the Diagnostic and Statistical Manual of Mental Disorders-IV-TR diagnostic criteria which consists of 18 items, grouped into “Part A” (6 items) and “Part B” (12 items). Part A is used as a screener, as the six components of this part are known to be the most predictive of ADHD symptoms. Each item is rated on a 4-point scale. If scores of 4 and above are recorded in Part A, the respondent is very likely to have adult ADHD. The K-ASRS showed satisfactory reliability in our sample (Cronbach’s alpha = 0.88).

Korean Version of the Center for Epidemiologic Studies Depression Scale-Revised: Depression symptoms were assessed with the Korean version of the Center for Epidemiologic Studies Depression Scale-Revised (K-CESD-R). The K-CESD-R consists of 20 items that ask about the depression symptoms experienced in the past week. Each item is scored on a 5-point ordinal scale based on frequency. Screening for a depressive state is deemed to be optimal with a cut-off point set at 13. Reliability of K-CESD-R in our sample was high (Cronbach’s alpha = 0.91).

Korean Mood Disorder Questionnaire: The Korean Mood Disorder Questionnaire (K-MDQ) is a self-reported inventory designed to screen for bipolar disorders. While the original MDQ consists of three criteria, the K-MDQ only utilizes the first criterion in the original MDQ. This is because the sensitivity of this instrument has been observed to decrease when the other two criteria were included. In accordance with the method adopted in the K-MDQ, a total of 7 points or more for the first criterion were considered an indication of bipolar disorder. Cronbach’s alpha of the K-MDQ in our sample was 0.77.

Korean Version of the Insomnia Severity Index: Insomnia symptoms were assessed with the Korean version of the Insomnia Severity Index (K-ISI). The K-ISI is a 7-item self-reported questionnaire, and each item is rated on a 5-point scale (0-4). A minimum cut-off score of 15 points is required for a positive screen for insomnia. Cronbach’s alpha of the K-MDQ in our sample was 0.86.

Korean Version of the Epworth Sleepiness Scale: Symptoms of excessive daytime sleepiness (EDS) were assessed with the Korean version of the Epworth Sleepiness Scale (K-ESS). The K-ESS consists of 8 items designed to assess sleepiness in 8 circumstances. Each item is rated on a 4-point scale (0-3), with values of 11 and above indicating sleepiness outside the range of normal in healthy adults. Cronbach’s alpha of K-ESS in our sample was 0.79.

Statistical Analysis
We divided the study population into ADHD screen-positive and ADHD screen-negative groups according to the K-ASRS cut-off point. Univariate logistic regression analyses were performed to assess whether there were differences in sociodemographic variables between ADHD screen-positive and negative groups.

We used Mann–Whitney U tests were used to measure the difference of K-ASRS, K-CESD-R, K-MDQ, K-ISI, and K-ESS between adult ADHD screen-positive and negative groups. This test was chosen as it does not assume a normal distribution of the data (Kolmogorov–Smirnov test, P < .001). Effect sizes were calculated with z value divided by square root of n.

The association of ADHD and mood/sleep symptoms was assessed using multiple logistic regression analyses. K-CESD-R, K-MDQ, K-ISI, and K-ESS scores were dichotomized according to the pre-determined cut-off points of each scale. Then four separate logistic regression analyses were conducted. The screen-positive of depression, bipolar, insomnia, and sleepiness symptoms were set as dependent variables in each analysis. In each analysis, screen-positive ADHD symptoms are set as the independent variable. Covariates in model 1 comprised, age, gender, education, marital status, occupation, and employment status. Further, in model 2, we added screen-positive of depression and bipolar as covariate to adjust the effect of mood on sleep problems. All dependent variables entered at the same time. Additional post hoc analysis was carried to measure statistical power (1-β).

Missing values were excluded from the analysis, and the significance level was set at P < .05. All statistical analyses were performed using SPSS Statistics 23.0 (IBM Corp., Armonk, NY, USA).

Results

Prevalence of adult ADHD symptom
Three percent (45 out of 1500) of the participants were positive in adult ADHD screening. No significant differences in sociodemographic characteristics were observed between the ADHD screen-positive and negative group (Table 1).
Assessment Scale Score Comparison Between the ADHD Screen Positive and Negative Group
The Mann–Whitney U test found that the ADHD screen-positive group show significantly higher median average than screen-negative group on K-ASRS [median 14 (10-18) vs. median 2 (0-14), \(P < .001\)], K-CESD-R [median 15 (0-42) vs. median 2 (0-42), \(P < .001\)], K-MDQ [median 11 (2-13) vs. median 10 (0-13), \(P = .02\)], K-ISI [median 11 (0-24) vs. median 1 (0-22), \(P < .001\)], and K-ESS [median 11 (0-24) vs. median 1 (0-22), \(P < .001\)], Table 2.

Association Between the Adult ADHD and Mood/Sleep Symptoms
The ADHD screen-positive group was associated with depression symptoms after adjusting for demographic characteristics including sex, age, educational level, marital status, religion, and employment status (OR = 11.89, 95% CI: 4.67-30.27, \(P < .001\)). However, the difference was no longer significant after adjusting for depression and bipolar symptoms (OR = 2.77, 95% CI: 0.94-8.18, \(P = .07\)).

The ADHD screen-positive group was more likely to have insomnia after adjusting for demographic characteristics (OR = 11.89, 95% CI: 4.67-30.27, \(P < .001\)). However, the difference was no longer significant after adjusting for depression and bipolar symptoms (OR = 2.77, 95% CI: 0.94-8.18, \(P = .07\)). The ADHD screen-positive group was more likely to have daytime sleepiness after adjusting for demographic characteristics (OR = 5.77, 95% CI: 2.99-11.14, \(P = .001\)). This remained significant after adjusting for mood symptoms, including depression symptoms and bipolar symptoms (OR = 3.18, 95% CI: 1.55-6.52, \(P < .001\), Table 3).

Discussion
In the present study, we found that 3% of the total sample population met the screening criteria for adult ADHD. This result is comparable with the findings of a previous study that reported worldwide prevalence of adult ADHD was 2.8%. Previous Korean study, published in 2011, reported that the prevalence rate of adult ADHD symptoms in Korea was 3.2%.

### Table 1. Demographic Characteristics of Subjects

| Characteristic          | ADHD Screen-Negative (n = 1455) | ADHD Screen-Positive (n = 45) | OR (95% CI) | \(P\) |
|-------------------------|----------------------------------|-----------------------------|-------------|-------|
| Sex                     |                                  |                             |             |       |
| Male                    | 744 (51.1)                       | 25 (55.6)                   | 1           | .60   |
| Female                  | 711 (48.9)                       | 20 (44.4)                   | 0.84 (0.46-1.52) |       |
| Age                     |                                  |                             |             |       |
| 19-29                   | 477 (32.8)                       | 13 (28.9)                   | 1.18 (0.57-2.46) | .65   |
| 30-39                   | 451 (31)                         | 15 (33.3)                   | 0.97 (0.48-1.96) | .93   |
| 40-49                   | 527 (36.2)                       | 17 (37.8)                   | 1           |       |
| Education (years)       |                                  |                             |             |       |
| \(<12\)                 | 426 (29.3)                       | 12 (26.7)                   | 1.14 (0.58-2.23) | .71   |
| \(>12\)                 | 1,029 (70.7)                     | 33 (73.3)                   | 1           |       |
| Religious affiliation   |                                  |                             |             |       |
| Yes                     | 381 (26.2)                       | 14 (31.1)                   | 0.79 (0.41-1.49) | .46   |
| No                      | 1,074 (73.8)                     | 31 (68.9)                   | 1           |       |
| Marital status          |                                  |                             |             |       |
| Never married           | 662 (45.5)                       | 20 (44.4)                   | 1           |       |
| Married                 | 784 (53.9)                       | 24 (53.3)                   | 0.99 (0.54-1.80) | .97   |
| Divorced/widowed        | 9 (0.6)                          | 1 (2.2)                     | 0.27 (0.03-2.25) | .23   |
| Employment              |                                  |                             |             |       |
| Yes                     | 1,057 (72.6)                     | 33 (73.3)                   | 1           | .92   |
| No                      | 398 (27.4)                       | 12 (26.7)                   | 1.04 (0.53-2.03) |       |

ADHD, Attention-deficit hyperactivity disorder; OR, odds ratio.

### Table 2. Mann–Whitney U-Test for ADHD, Mood- and Sleep-Related Items Between Adult ADHD Screen-Negative and Positive Group

|               | Non-ADHD Symptom Group (n = 1455) | ADHD Symptom Group (n = 45) | P     | Effect Size (\(r\)) |
|---------------|----------------------------------|-----------------------------|-------|----------------------|
| ASRS          | 2.00 (0-14)                      | 14.00 (10-18)               | <.001 | 0.30                 |
| CES-D         | 2.00 (0-42)                      | 15.00 (0-42)                | <.001 | 0.17                 |
| MDQ           | 10.00 (0-13)                     | 11.00 (2-13)                | .02   | 0.08                 |
| ISI           | 1.00 (0-22)                      | 11.00 (0-24)                | <.001 | 0.23                 |
| ESS           | 4.00 (0-23)                      | 9.00 (1-16)                 | <.001 | 0.18                 |

Mann–Whitney U tests are calculated between ADHD screen-negative and positive groups for ASRS, CES-D, MDQ, ISI, ESS. ADHD, Attention-deficit hyperactivity disorder; ASRS, Adult ADHD Self-Report Scale; CES-D, Center for Epidemiologic Studies-Depression Scale; MDQ, Mood Disorder Questionnaire; ISI, Insomnia Severity index; ESS, Epworth Sleepiness Scale.
was 1.1%, which was lower than the prevalence rate of Western study. For the past 10 years, a lot of publicity has been carried out in Korea to raise awareness of adult ADHD. In our result, the similar prevalence to Western counties may reflect the improved public acceptance of adult ADHD symptoms.

Adult ADHD and Mood Symptoms
In this study, the risk of depression was found to be 14-fold higher in the ADHD group. This is consistent with the findings of earlier studies, which reported prevalence rates of depression ranging from 18% to 53% among adults with ADHD. In a previous study utilizing a community sample, an adult ADHD group showed a 3-fold (OR = 2.7) higher rate of comorbidity with major depressive disorders, and a 7-fold (OR = 7.5) higher rate of comorbidity with dysthymic disorder, compared to a non-ADHD group. When compared with these results, our study yielded a higher odds ratio (OR = 14.9), presumably because we assessed depressive symptoms using a screening tool rather than strict diagnostic instruments. And, it is worth pointing out that the prevalence of depression itself in the general population is high. In our study, the prevalence of depression in the ADHD screen-positive group (54%) was higher than the general prevalence. However, our cross-sectional design makes it impossible to investigate temporal association between ADHD and depression. Our findings only suggest that symptoms of ADHD and depression coexist.

There are a variety of hypotheses for the high rates of comorbidity of depression in individuals with ADHD, including reward responsibility, family support, and emotional regulation. It has also been noted that depression and ADHD are likely to co-occur because they have similar biochemical etiology. The major physiological causes of ADHD, including the catecholaminergic, serotonergic, and cholinergic pathways, are known to be also strongly associated with depression.

The high rate of comorbidity between depression and ADHD highlights the importance of verifying whether ADHD is the underlying cause of depression. A recent study revealed that 28% of treatment-resistant depression patients had undetected ADHD. The main complaints of patients with both ADHD and depression often consist of emotional dysregulation, rather than ADHD symptoms themselves.

In addition, patients with depression also manifest symptoms such as difficulty concentrating, restlessness, irritability, and difficulty falling asleep, which are also observed in ADHD.

In our study, no association between adult ADHD and bipolar symptoms was observed. Previous studies on comorbidity of ADHD and bipolar disorder have yielded inconsistent results. Childhood ADHD and bipolar disorder were reported to have a high co-existence rate in studies conducted in Italy (16.7%), the United States (23%), and Turkey (8.3%). In a study conducted among adults with ADHD, 20% were found to have concurrent bipolar disorder. In contrast, another study has also reported the lack of an association between bipolar disorder and ADHD. In a recent study conducted in the UK, only 0.5% of children with ADHD met the diagnostic criteria for bipolar disorder, a rate which was no different when compared to the control group.

### Table 3. Logistic Regression Analysis for Comorbid Symptoms Among Subjects with Adult ADHD Screen-Positive

|                  | ADHD Screen-Negative (n = 1455) | ADHD Screen-Positive (n = 45) | Model 1<sup>a</sup> | Model 2<sup>b</sup> | Power (1-β)<sup>d</sup> |
|------------------|---------------------------------|-------------------------------|----------------------|----------------------|--------------------------|
|                  | n (%)                           | B (SE)                        | OR (95% CI)          | R<sup>2</sup>        | P                        | B (SE) | OR (95% CI) | R<sup>2</sup> | P | (1-β)        |
| Depression symptom | 99 (6.8)                        | 2.71 (0.32)                   | 14.97 (7.94-28.25)   | 0.12                 | <.001                    | -      | -            | -            | - | 0.87          |
| Bipolar symptom   | 136 (9.3)                       | 0.53 (0.43)                   | 1.70 (0.74-3.93)     | 0.02                 | .210                     | -      | -            | -            | - | 0.13          |
| Insomnia symptom  | 24 (1.6)                        | 2.48 (0.48)                   | 11.89 (4.67-30.27)   | 0.11                 | <.001                    | 1.02 (0.55) | 2.77 (0.94-8.18) | 0.32 | .065 | 0.22          |
| Daytime sleepiness | 122 (8.4)                       | 1.75 (0.34)                   | 5.77 (2.99-11.14)    | 0.05                 | <.001                    | 1.16 (0.37) | 3.18 (1.55-6.53) | 0.09 | .002 | 0.36          |

ADHD, Attention-deficit hyperactivity disorder; B, regression coefficient; SE, standard error; OR, odds ratio. Predictor: screen-positive for adult ADHD symptoms. Dependent variables: screen-positive for depression, bipolar, insomnia, and sleepiness symptoms.

<sup>a</sup>Model 1: Adjusted for gender, age, education, religion, marital status, employment; <sup>b</sup>Model 2: Model 1 + adjusted for screen-positive for depression and bipolar symptoms; <sup>d</sup>Nagelkerke R<sup>2</sup> square; <sup>P</sup>Post hoc.

### Adult ADHD and Sleep Symptoms
Our regression model indicated the association between adult ADHD and insomnia was no longer significant after adjusting mood symptoms. This result suggests that insomnia can act as a mediating variable in adult ADHD. This result is consistent with a meta-analysis study investigating the association between ADHD and sleep did not find a significant relationship after adjusting for comorbidities.

Regarding the association between ADHD and insomnia symptoms, it is suggested that mood symptoms play a key role in mediating sleep symptoms in ADHD. As noted previously, depression has a high comorbidity rate in ADHD. Depression manifests as sleep-related symptoms such as bedtime resistance, delayed sleep onset, and difficulty with sleep maintenance. Given the effects of depression on sleep, it is not surprising that this disorder can also cause sleep problems in individuals with comorbid ADHD.

Our result indicated that the adult ADHD group is more likely to have daytime sleepiness. This result remained significant after adjusting for mood symptoms. This is consistent with the findings of a previous study that reported an EDS prevalence of 37% in an adult ADHD group, and that 18% of the EDS group also satisfied the ADHD diagnostic criteria. Previous studies have suggested that daytime sleepiness in adult ADHD is attributable to the lack of sleep due to frequent
arousal during sleep, or sleep phase delay due to an altered circadian pattern.

Several limitations are acknowledged in the current study. It is important to note that our study screened the symptom to make a formal diagnosis of ADHD, mood, and sleep. So that it was not possible to make diagnosis of specific disorder. This study was based on screening questionnaires with a cut-off threshold. Although questionnaires in our study are a tool widely used in epidemiological research and has good reliability and validity, their diagnostic application is limited. Another limitation inherent to self-reported assessments is recall bias. This could not be precluded as the respondents relied on their memory during the questionnaire survey. Our cross-sectional design limited the ability to investigate causal relationship between adult ADHD and mood and sleep problems. Additionally, this study did not examine the medication history (current medication, medication duration, drug treatment) of the respondents. Indeed, depression and insomnia have been reported as side effects of ADHD medication. Also, we did not assess anxiety symptoms and substance abuse history, which are highly comorbid with adult ADHD and could interact with our study variables.

In summary, we investigated the prevalence of adult ADHD in the community sample and the association between adult ADHD and mood- and sleep-related symptoms. Of the total number of subjects assessed, 3% met the adult ADHD screening criteria. Adult with ADHD has more likely to have depressive symptoms and daytime sleepiness. Comorbid symptoms complicate the diagnosis, treatment of adult ADHD. Clinically, it is recommended that adults presenting with symptoms of depression and/or sleepiness should also be examined for ADHD symptom and vice versa.

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