



Sex Differences in Risk Factors for Generalized Anxiety Disorder in Korean Adolescents

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Objectives: This study aimed to examine sex differences in the risk factors associated with generalized anxiety disorder (GAD) among Korean adolescents to provide insights for drafting more effective prevention strategies.

Methods: Data from 51845 middle and high school students in the 18th Korea Youth Risk Behavior Web-based Survey were analyzed. GAD was assessed using the 7-item Generalized Anxiety Disorder tool, and factors such as grade, academic performance, economic status, living arrangements, smoking, drinking, sexual experience, and physical activity were included. The prevalence of GAD and its association with these factors were compared between male and female students using chi-square tests and logistic regression. Odds ratios were compared statistically to identify sex-specific differences.

Results: GAD prevalence was higher among girls (42.1%) than boys (30.1%). Both sexes showed increased GAD risk with lower academic performance, lower economic status, smoking, drinking, and sexual experience. Boys living apart from their families had a higher GAD risk, but this was not significant for girls. Additionally, smoking and drinking were associated with a higher increase in GAD risk in girls than in boys.

Conclusion: This study underscores the importance of considering sex differences in the prevention of GAD among adolescents. Tailored sex-specific interventions are crucial for effective prevention and management of GAD in Korean adolescents.

Keywords: Adolescents; Mental health; Risk factors; Health risk behaviors; Sex differences.

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INTRODUCTION

Adolescent mental health issues are becoming increasingly severe in modern society. According to the 18th Korea Youth Risk Behavior Web-based Survey (KYRBS) conducted in 2022, mental health indicators such as perceived stress levels, depression experiences, suicidal ideation, feelings of loneliness, and moderate-to-severe generalized anxiety disorder (GAD) have increased among both male and female students compared to the previous year [1]. In particular, the prevalence of moderate-to-severe GAD, which was added as a survey item in 2020, has increased from 11.2% in 2020 to 12.7% in 2022 [1].

GAD is a subtype of anxiety disorder characterized by pervasive and persistent anxiety that is not limited to specific situations or environments and causes significant distress and impairment in social and occupational functioning. Anxiety symptoms that occur during adolescence can

be considered early signs of various psychopathologies, potentially leading to other anxiety disorders and mental health conditions [2]. Therefore, early detection and prevention of anxiety symptoms during adolescence are important.

Previous studies have reported risk factors associated with mental health, such as sex, economic status, stress, and emotional states, such as sadness, loneliness, suicidal thoughts, and physical activity [2,3]. Additionally, specific experiences during adolescence, such as substance use, smartphone overdependence, and exposure to violence are associated with mental health [4]. However, previous cross-sectional studies have examined associations without considering the temporal characteristics reflected in the survey questionnaires, making it impossible to rule out the possibility of reverse causation. Additionally, these studies have analyzed the overall population without accounting for sex differences despite recognizing sex as a factor related to mental health [2-4]. Males and females may differ in the factors associated with mental health due to biological, psychological, and social differences. Therefore, it is essential to consider that different factors may influence mental health differently in each sex.

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This study examined the risk factors associated with mental health among Korean adolescents according to sex. We found sex-differences in risk factors affecting the mental health of Korean adolescents by comparing the differences in risk factors by sex and ultimately suggested the need for different approaches in the prevention of mental health issues based on sex.

METHODS

Study population

This study was performed using the 18th KYRBS (2022), a nationwide cross-sectional survey assessing the health status of adolescents in Korea. The Korea Disease Control and Prevention Agency conducts this survey annually using a stratified multistage cluster sampling method to obtain a nationally representative sample of middle- and high-school adolescents in Korea [5]. For this study, 2022 data, which were the most recent data available at the time of planning, were used. The target population was defined as students enrolled in middle and high schools nationwide as of April 2022, and the sampling frame for the sample design used data from nationwide middle and high schools as of April 2021. The sample comprised 400 middle schools and 400 high schools. Initially, five middle schools and five high schools were allocated to each of the 17 provinces and metropolitan areas. Proportional allocation was applied to ensure consistency between the population and sample composition using stratification variables, distributing the sample schools according to province, city size, region, and school type. Among the 800 selected schools, including 400 middle and 400 high schools, and 56213 sample students, 51850 (92.2%) students from 798 (99.8%) schools participated in the survey that year. After excluding those with missing information on academic performance ($n=2$) and economic status ($n=3$), 51845 students (26393 boys and 25452 girls) were included in the analyses. Although five participants had missing values for living arrangements, they overlapped with those with missing values for academic performance and economic status. A trained teacher distributes an information sheet to each student and, using instructional materials (such as an animation or PowerPoint presentation), explains the purpose and procedures of the survey in a school computer laboratory equipped with Internet access. Students then log in with the certificate number provided on the information sheet and complete the online informed consent process. This study was reviewed and approved by the Institutional Review Board of Eulji University (EUIRB2024-007). Informed consent was waived since secondary data were used in this study.

Measurements

Mental health

Adolescent mental health was assessed using the 7-item Generalized Anxiety Disorder (GAD-7) tool [6]. This tool evaluates the frequency of seven issues experienced over the past two weeks: worry, nervousness, anxiety, discomfort, irritability, fear, and disturbance [6]. Responses were scored as follows: “not at all” (0 points), “several days” (1 point), “more than half of the days” (2 points), and “nearly every day” (3 points). The scores for all the items were summed to obtain a total score. A total score of 0–4 points indicated “normal” anxiety levels, 5–9 points indicated “mild anxiety,” 10–14 points indicated “moderate anxiety,” and 15–21 points indicated “severe anxiety.” Individuals scoring 0–4 were categorized as having no GAD, while those scoring 5 or above were categorized as having GAD according to “2020 Standard Guidelines for Mental Health Screening Tools and Their Use” [7]. Although the study participants were patients with migraine, validation of the GAD-7 at a cutoff score of 5 for the Korean population has been reported in a previous study [8].

General characteristics

Variables related to the general characteristics of the adolescent subjects, including grade, academic performance, economic status, and living arrangements, were used. Grade level was surveyed from the first year of middle school to the third year of high school and used as a variable reflecting age. Academic performance was assessed over the past 12 months and categorized into five levels: high, middle-high, middle, middle-low, and low. The economic status of households was categorized into five levels: high, middle-high, middle, middle-low, and low. Living arrangements were surveyed with five options: “living with family,” “living with relatives,” “boarding or living alone (including living with friends),” “dormitory,” and “care facility (orphanage, social welfare facility, childcare facility).” These were reclassified into a binary variable indicating whether students lived with their families.

Risk behaviors

To examine the association between major risky lifestyle behaviors such as smoking, drinking, sexual activity, physical inactivity, and GAD in adolescents, we used risk behavior variables such as smoking experience, drinking experience, sexual activity experience, and the number of days with at least 60 minutes of physical activity. Assuming that lifetime experiences of smoking or drinking have a more significant impact on current mental health by explaining the temporal relationship better than current smoking and drink-

ing status, we used variables reflecting whether students had ever smoked or drank alcohol during their lifetime. Smoking experience was assessed based on whether the individual had ever consumed even a few puffs in their lifetime, where-

as drinking experience was assessed based on whether the individual had ever consumed at least one drink in their lifetime. Sexual activity experience was assessed by asking, "Have you ever had sexual intercourse?" and the responses were re-

Table 1. Comparison between male and female students regarding general characteristics, risk behaviors, and generalized anxiety disorder

| Characteristics | Male | | Female | | p* |
|------------------------------------|--------------|------|--------------|------|---------|
| | Value† | SE† | Value† | SE† | |
| Total | 26393 (51.6) | 1.21 | 25452 (48.4) | 1.21 | |
| Mean age of middle school students | 13.8±0.01 | | 13.8±0.01 | | |
| Mean age of High school students | 16.7±0.01 | | 16.7±0.01 | | |
| Grade | | | | | 0.9998 |
| Middle school 1st grade | 4745 (16.4) | 0.52 | 4493 (16.5) | 0.52 | |
| Middle school 2nd grade | 4736 (17.1) | 0.53 | 4610 (17.2) | 0.53 | |
| Middle school 3rd grade | 4700 (18.0) | 0.60 | 4729 (18.1) | 0.58 | |
| High school 1st grade | 4234 (16.4) | 0.57 | 4224 (16.4) | 0.54 | |
| High school 2nd grade | 4164 (15.6) | 0.52 | 3818 (15.4) | 0.58 | |
| High school 3rd grade | 3814 (16.6) | 0.59 | 3578 (16.4) | 0.59 | |
| Academic performance | | | | | <0.0001 |
| High | 3903 (14.9) | 0.31 | 3032 (12.0) | 0.29 | |
| Middle-high | 6524 (24.9) | 0.32 | 6591 (25.8) | 0.35 | |
| Middle | 7610 (28.9) | 0.31 | 7873 (31.3) | 0.35 | |
| Middle-low | 5664 (21.2) | 0.33 | 5715 (22.4) | 0.34 | |
| Low | 2692 (10.2) | 0.23 | 2241 (8.6) | 0.23 | |
| Economic status | | | | | <0.0001 |
| High | 3426 (13.3) | 0.32 | 2558 (10.3) | 0.32 | |
| Middle-high | 8392 (32.3) | 0.41 | 7512 (30.5) | 0.42 | |
| Middle | 11702 (43.9) | 0.47 | 12439 (48.3) | 0.49 | |
| Middle-low | 2298 (8.4) | 0.24 | 2509 (9.3) | 0.25 | |
| Low | 575 (2.1) | 0.10 | 434 (1.6) | 0.09 | |
| Living arrangements | | | | | 0.0060 |
| With family | 24836 (94.8) | 0.51 | 24346 (96.7) | 0.34 | |
| Apart from family | 1557 (5.2) | 0.51 | 1106 (3.7) | 0.34 | |
| Smoke experience | | | | | <0.0001 |
| No | 23306 (88.0) | 0.36 | 23994 (94.4) | 0.21 | |
| Yes | 3087 (12.0) | 0.36 | 1458 (5.6) | 0.21 | |
| Drink experience | | | | | <0.0001 |
| No | 16184 (61.2) | 0.55 | 18046 (70.8) | 0.52 | |
| Yes | 10209 (38.8) | 0.55 | 7406 (29.2) | 0.52 | |
| Sexual experience | | | | | <0.0001 |
| No | 24471 (92.4) | 0.25 | 24286 (95.3) | 0.17 | |
| Yes | 1922 (7.6) | 0.25 | 1166 (4.7) | 0.17 | |
| Sufficient physical activity | | | | | <0.0001 |
| No | 13549 (51.8) | 0.42 | 18682 (74.0) | 0.46 | |
| Yes | 12844 (48.2) | 0.42 | 6770 (26.0) | 0.46 | |
| Generalized anxiety disorder | | | | | <0.0001 |
| No | 18593 (69.9) | 0.34 | 14772 (57.9) | 0.40 | |
| Yes | 7800 (30.1) | 0.34 | 10680 (42.1) | 0.40 | |

Data are presented as mean ± standard error or n (%). *Rao-Scott chi-square test following complex sample survey; †weighted percent and standard error were estimated based on a complex sample design. SE, standard error

corded as a binary variable (yes or no). The physical activity variable was measured by the number of days in the past seven days that the individual engaged in at least 60 minutes of moderate to vigorous physical activity, causing increased heart rate or shortness of breath. Considering that the weekly lifestyle patterns of middle and high school students in Korea are relatively consistent, we assumed that although the survey measured only the number of days in the past week with at least 60 minutes of moderate-to-vigorous physical activity, which increases the heart rate or causes shortness of breath, it would reflect the students' overall physical activity habits. According to the World Health Organization guidelines, sufficient physical activity is defined as at least 150 minutes per week [9]; thus, individuals were considered to have sufficient physical activity if they reported engaging in such activity for at least three days per week.

Statistical analysis

We first compared the general characteristics, risk behaviors, and prevalence of GAD between adolescent males and females in Korea to highlight the need for separate analyses by sex owing to differences between them. Differences between male and female students were tested using the Rao-Scott chi-square test, reflecting the weights of the complex sample survey.

Based on the differences between male and female students, factors associated with GAD for each sex were identified using the Rao-Scott chi-square test and multiple logistic regression analysis by considering the weights of the complex sample survey. Based on the estimated odds ratios (ORs) for boys and girls, significant differences between the sexes were analyzed to determine which risk factors were more significant for each sex [10].

$$Z = \frac{\log(OR_{men}) - \log(OR_{women})}{\sqrt{SE_{men}^2 + SE_{women}^2}}$$

All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

RESULTS

Statistically significant differences between male and female students, except for grades, are shown in Table 1. No difference in grade distribution by sex indicated that sampling was conducted equally across grades for both sexes; however, significant differences between male and female students were observed for all other variables, suggesting the need for separate analyses for boys and girls. In terms of academic performance, boys were relatively more prevalent in

the extreme categories of high and low than girls, whereas girls were more represented in the middle-low to middle-high range. Boys tended to have better economic status than girls, and a slightly higher percentage of girls lived with their families. Boys had higher rates of smoking, drinking, and sexual experience and also engaged in sufficient physical activity more frequently than girls. The prevalence of GAD was significantly higher in girls (42.1%) than in boys (30.1%).

Table 2 shows the distribution of general characteristics and risk behaviors according to the presence of GAD for each sex. Significant differences in GAD prevalence were observed across grades in both boys and girls. For both sexes, lower academic performance and lower economic status were associated with a higher prevalence of GAD. Additionally, boys living apart from their families experienced GAD in more cases (6.5%) than girls did (3.8%). Smoking, drinking, and sexual experiences were associated with a higher prevalence of GAD in both boys and girls.

The results of the multivariate logistic regression analysis, adjusted for the influence of each factor, showed that lower academic performance, lower economic status, smoking experience, drinking experience, and sexual experience were associated with an increased risk of GAD in both male and female (Table 3). In particular, boys in the third year of middle school (OR=1.15, 95% confidence interval [CI]: 1.03–1.28) and the third year of high school (OR=1.16, 95% CI: 1.02–1.32) had a higher risk of GAD compared to those in the first year of middle school. In contrast, girls showed a decreased risk of GAD in the second year of high school (OR=0.82, 95% CI: 0.73–0.92) compared to the first year of middle school. However, no significant differences were observed between boys and girls in these comparisons. The risk of GAD increased only for boys who were living apart from their families (OR=1.30, 95% CI: 1.13–1.49), showing a significant difference between boys and girls ($p=0.0006$). Smoking and drinking experience increased the risk of GAD for both boys (OR=1.18, 95% CI: 1.07–1.30 for smoking experience and OR=1.17, 95% CI: 1.09–1.25 for drinking experience) and girls (OR=1.53, 95% CI: 1.34–1.76 for smoking experience and OR=1.40, 95% CI: 1.31–1.51 for drinking experience), however the risk was found to be particularly higher in girls when comparing the ORs between them (Table 3).

DISCUSSION

This study examined the risk factors associated with GAD in Korean adolescents and found significant differences in several factors between males and females. The prevalence of GAD was higher among female students (42.1%) than male students (30.1%). Although common risk factors were ob-

Table 2. General characteristics, risk behaviors according to the generalized anxiety disorder by sex

| Characteristics | Generalized anxiety disorder (male) | | | | Generalized anxiety disorder (female) | | | | |
|------------------------------|-------------------------------------|-----------------|--------------------|-----------------|---------------------------------------|-----------------|--------------------|-----------------|---------|
| | No | | Yes | | No | | Yes | | |
| | n (%) [†] | SE [†] | n (%) [†] | SE [†] | n (%) [†] | SE [†] | n (%) [†] | SE [†] | |
| Grade | | | | | | | | | |
| Middle school 1st grade | 3518 (17.3) | 0.48 | 1227 (14.3) | 0.55 | 2720 (17.2) | 0.51 | 1773 (15.6) | 0.53 | <0.0001 |
| Middle school 2nd grade | 3404 (17.4) | 0.49 | 1332 (16.4) | 0.61 | 2627 (16.8) | 0.51 | 1983 (17.8) | 0.56 | |
| Middle school 3rd grade | 3280 (17.9) | 0.55 | 1420 (18.2) | 0.69 | 2691 (17.8) | 0.55 | 2038 (18.5) | 0.61 | |
| High school 1st grade | 2945 (16.2) | 0.51 | 1289 (16.8) | 0.65 | 2462 (16.6) | 0.52 | 1762 (16.0) | 0.55 | |
| High school 2nd grade | 2892 (15.4) | 0.48 | 1272 (15.9) | 0.59 | 2312 (16.2) | 0.60 | 1506 (14.3) | 0.56 | |
| High school 3rd grade | 2554 (15.9) | 0.55 | 1260 (18.4) | 0.71 | 1960 (15.4) | 0.54 | 1618 (17.8) | 0.68 | |
| Academic performance | | | | | | | | | |
| High | 2804 (15.3) | 0.34 | 1099 (14.0) | 0.46 | 1857 (12.6) | 0.39 | 1175 (11.1) | 0.36 | <0.0001 |
| Middle-high | 4623 (25.0) | 0.36 | 1901 (24.8) | 0.55 | 3901 (26.2) | 0.44 | 2690 (25.1) | 0.51 | |
| Middle | 5528 (29.8) | 0.37 | 2082 (26.7) | 0.50 | 4726 (32.3) | 0.45 | 3147 (29.9) | 0.52 | |
| Middle-low | 3913 (20.8) | 0.37 | 1751 (22.1) | 0.55 | 3219 (21.8) | 0.41 | 2496 (23.2) | 0.47 | |
| Low | 1725 (9.2) | 0.24 | 967 (12.4) | 0.44 | 1069 (7.1) | 0.26 | 1172 (10.8) | 0.36 | |
| Economic status | | | | | | | | | |
| High | 2531 (13.9) | 0.36 | 895 (12.0) | 0.46 | 1621 (11.3) | 0.37 | 937 (9.1) | 0.38 | <0.0001 |
| Middle-high | 6044 (32.9) | 0.44 | 2348 (30.8) | 0.64 | 4527 (31.3) | 0.49 | 2985 (29.3) | 0.55 | |
| Middle | 8315 (44.3) | 0.50 | 3387 (42.8) | 0.71 | 7307 (48.9) | 0.58 | 5132 (47.4) | 0.58 | |
| Middle-low | 1397 (7.2) | 0.24 | 901 (11.0) | 0.42 | 1148 (7.4) | 0.25 | 1361 (11.9) | 0.39 | |
| Low | 306 (1.6) | 0.10 | 269 (3.3) | 0.23 | 169 (1.1) | 0.11 | 265 (2.3) | 0.15 | 0.6728 |
| Living arrangements | | | | | | | | | |
| With family | 17599 (95.4) | 0.40 | 7237 (93.5) | 0.69 | 14159 (96.4) | 0.38 | 10187 (96.2) | 0.33 | |
| Apart from family | 994 (4.6) | 0.40 | 563 (6.5) | 0.69 | 613 (3.6) | 0.38 | 493 (3.8) | 0.33 | |
| Sufficient physical activity | | | | | | | | | |
| No | 9466 (51.5) | 0.45 | 4083 (52.6) | 0.67 | 10882 (74.2) | 0.49 | 7800 (73.6) | 0.59 | 0.2730 |
| Yes | 9127 (48.5) | 0.45 | 3717 (47.4) | 0.37 | 3890 (25.8) | 0.49 | 2880 (26.4) | 0.59 | <0.0001 |
| Smoke experience | | | | | | | | | |
| No | 16641 (89.3) | 0.33 | 6665 (85.3) | 0.51 | 14176 (96.1) | 0.21 | 9818 (92.1) | 0.32 | <0.0001 |
| Yes | 1952 (10.7) | 0.33 | 1135 (14.7) | 0.51 | 596 (3.9) | 0.21 | 862 (7.9) | 0.32 | |
| Drink experience | | | | | | | | | |
| No | 11765 (63.0) | 0.56 | 4419 (56.9) | 0.71 | 11064 (74.9) | 0.56 | 6983 (65.3) | 0.63 | <0.0001 |
| Yes | 6828 (37.0) | 0.56 | 3381 (43.1) | 0.71 | 3708 (25.1) | 0.56 | 3698 (34.7) | 0.63 | |
| Sexual experience | | | | | | | | | |
| No | 17375 (93.1) | 0.25 | 7096 (90.6) | 0.39 | 14262 (96.5) | 0.18 | 10024 (93.8) | 0.26 | <0.0001 |
| Yes | 1218 (6.9) | 0.25 | 704 (9.4) | 0.39 | 510 (3.5) | 0.18 | 656 (6.2) | 0.26 | |

*Rao-Scott chi-square test following complex sample survey; [†]weighted percent and standard error were estimated based on a complex sample design. SE, standard error

Table 3. Sex differences in factors associated with generalized anxiety disorder

| | Male | | Female | | p [†] |
|-------------------------------------|------|-----------|--------|-----------|----------------|
| | OR* | 95% CI | OR* | 95% CI | |
| Grade | | | | | |
| Middle school 1st grade | 1.00 | Reference | 1.00 | Reference | |
| Middle school 2nd grade | 1.10 | 0.99–1.23 | 1.10 | 1.00–1.22 | >0.9999 |
| Middle school 3rd grade | 1.15 | 1.03–1.28 | 1.05 | 0.94–1.16 | 0.2383 |
| High school 1st grade | 1.10 | 0.99–1.23 | 0.93 | 0.84–1.04 | 0.0307 |
| High school 2nd grade | 1.05 | 0.94–1.18 | 0.82 | 0.73–0.92 | 0.0028 |
| High school 3rd grade | 1.16 | 1.02–1.32 | 1.04 | 0.92–1.17 | 0.2246 |
| Academic performance | | | | | |
| High | 1.00 | Reference | 1.00 | Reference | |
| Middle-high | 1.06 | 0.97–1.17 | 1.05 | 0.94–1.16 | 0.8951 |
| Middle | 0.93 | 0.85–1.02 | 1.00 | 0.89–1.11 | 0.3206 |
| Middle-low | 1.04 | 0.93–1.15 | 1.07 | 0.96–1.19 | 0.7120 |
| Low | 1.20 | 1.06–1.37 | 1.36 | 1.20–1.55 | 0.1758 |
| Economic status | | | | | |
| High | 1.00 | Reference | 1.00 | Reference | |
| Middle-high | 1.09 | 0.99–1.21 | 1.18 | 1.07–1.30 | 0.2660 |
| Middle | 1.10 | 1.00–1.22 | 1.20 | 1.09–1.33 | 0.2253 |
| Middle-low | 1.68 | 1.48–1.91 | 1.85 | 1.64–2.09 | 0.2830 |
| Low | 1.96 | 1.59–2.42 | 2.15 | 1.69–2.75 | 0.5727 |
| Living arrangement | | | | | |
| With family | 1.00 | Reference | 1.00 | Reference | |
| Apart from family | 1.30 | 1.13–1.49 | 0.90 | 0.77–1.06 | 0.0006 |
| Sufficient physical activity | | | | | |
| No | 1.00 | Reference | 1.00 | Reference | |
| Yes | 0.96 | 0.90–1.02 | 1.02 | 0.96–1.09 | 0.1826 |
| Smoke experience | | | | | |
| No | 1.00 | Reference | 1.00 | Reference | |
| Yes | 1.18 | 1.07–1.30 | 1.53 | 1.34–1.76 | 0.0024 |
| Drink experience | | | | | |
| No | 1.00 | Reference | 1.00 | Reference | |
| Yes | 1.17 | 1.09–1.25 | 1.40 | 1.31–1.51 | 0.0004 |
| Sexual experience | | | | | |
| No | 1.00 | Reference | 1.00 | Reference | |
| Yes | 1.15 | 1.02–1.30 | 1.26 | 1.09–1.44 | 0.3322 |

*multivariate logistic regression based on a complex sample design adjusting for grade, academic performance, economic status, living arrangements, sufficient physical activity, smoke experience, drink experience, sexual experience; †p-values are derived from Z-tests comparing the log-transformed odds ratios between male and female. CI, confidence interval; OR, odds ratio

served in both sexes, including lower academic performance, lower economic status, smoking experience, drinking experience, and sexual experience, females showed a higher risk of GAD related to smoking and drinking experience than males. Moreover, living apart from family was identified as a specific risk factor for GAD among males.

Statistics from the 18th KYRBS estimated the prevalence of moderate or higher GAD, reporting 8.0% for male students and 14.7% for female students in 2020, and 9.7% for male students and 15.9% for female students in 2022 [1]. However, in

our study, GAD was defined as the presence of mild or higher anxiety using a cutoff score of 5, based on the 2020 Standard Guidelines for Mental Health Screening Tools and Their Use [7]. Consequently, its prevalence is estimated to be high. In a previous study, when a cutoff score of 5 was used, the GAD prevalence in 2020 was 27.3% in males and 40.4% in females [11]. Given the slight increase in the prevalence of moderate or higher GAD from 2020 to 2022, the prevalence of GAD, defined as mild or higher anxiety in our study, also showed a slight increase to 30.1% in males and 42.1% in fe-

males compared with 2020.

Consistent with earlier studies, this study found that a higher risk of GAD was observed in both male and female students with lower academic performance, lower economic status, smoking experience, drinking experience, and sexual experience [2-4]. However, we focused on sex-specific differences to provide additional insight into how these factors differentially affect boys and girls. While both smoking and drinking were associated with an increased risk of GAD in males, the risk was significantly higher in females with similar experiences. Specifically, female smokers are at a greater risk of developing GAD than male smokers, and the same pattern is observed in females who drink alcohol compared with their male counterparts. This suggests that, although boys are generally more likely to engage in behaviors such as smoking and drinking [1], the mental health consequences of these behaviors may be more severe for girls [12,13]. The stigma and social pressures associated with smoking and drinking in girls, along with physiological differences in how substances affect the female body, likely contribute to this increased vulnerability [14-16].

For boys, the risk of GAD was particularly elevated during the third year of middle school and the third year of high school, which are critical academic transition periods in the Korean educational system. Although previous studies have not reported differences between boys and girls in terms of anxiety related to academic pressure [17], the results of this study imply that these periods are marked by intense academic pressure, which appears to disproportionately affect boys, leading to higher anxiety levels. Additionally, boys who lived away from their families exhibited a higher risk of developing GAD. These findings suggest that boys may be more susceptible to anxiety in the face of environmental changes, such as the pressures of academic transitions and stress associated with living independently from their families [18-20].

Sex differences in mental health are crucial, especially during adolescence, a period marked by significant biological, psychological, and social changes [21]. Our findings indicate that boys are more likely to experience heightened anxiety during major life transitions and when separated from familial support, whereas girls are more vulnerable to the adverse mental health effects of risky behaviors such as smoking and drinking. These differences are influenced by various factors, including hormonal changes, gender roles, and societal expectations [22]. In Korea, traditional gender roles and the pressure to conform to societal norms can exacerbate these issues differently for boys and girls [17,23,24]. Understanding these differences is crucial for developing targeted interventions that address the specific needs of each sex. For instance, it may be helpful for males to increase their com-

munication time with their families through family-participatory activities to strengthen family bonds and relieve anxiety through active counseling support with a psychologist [25,26]. For females, it may be helpful to provide step-by-step and systematic preventive education on the risks of smoking and drinking, centered on schools and communities [27-29].

The current study had several limitations. First, adolescents may under-report or over-report their mental health status and behavior because of social desirability or recall bias. Second, to measure smoking and drinking behaviors, we categorized the subjects into those with and without smoking experience, and those with and without drinking experience. However, this simple classification may not fully capture the frequency or intensity of smoking and drinking. Third, the GAD-7 is a screening tool consisting of seven questionnaire items designed to quickly screen for GAD. Therefore, the diagnosis of GAD was limited. Finally, the cross-sectional design limits the ability to establish causal relationships between the identified risk factors and GAD. However, we also considered the temporal characteristics of the questionnaire. For example, the GAD questions referred to experiences in the past two weeks, while the variables selected as potential risk factors reflected more general or long-term states to ensure that they preceded the timeframe covered by the GAD assessment. Although physical activity was assessed based on the past week, we assumed that the physical activity patterns of Korean middle and high school students were consistent. Thus, the past week's activity reflected the student's overall pattern. Therefore, although this was a cross-sectional study, we attempted to interpret the temporal relationship using variables that reflected periods prior to GAD as potential risk factors. However, the limitation remains that it is difficult to establish a clear temporal relationship because of the possibility that GAD symptoms can persist beyond two weeks and the influence of experiences from other variables occurring within the same two-week period. Nevertheless, this study has several strengths, including its large, nationally representative sample, which enhances the generalizability of the findings, and its focus on sex-specific factors, which provide valuable insights into how boys and girls experience mental health risks differently.

CONCLUSION

This study highlighted the importance of considering sex differences when addressing mental health issues among adolescents. These findings suggest that boys and girls have different risk factors for mental health problems. These insights underscore the need for tailored interventions that consider sex-specific factors to effectively prevent and manage anxi-

ety disorders among Korean adolescents. Future research should explore these differences and investigate other factors that may contribute to young people's mental health during this critical developmental period.

Availability of Data and Material

The raw dataset analyzed during the current study are available at <http://www.kdca.go.kr/yhs/>.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

Author Contributions

Conceptualization: Yea-Ju Jin, JooYong Park. Data curation: Yea-Ju Jin. Investigation: Yea-Ju Jin, JooYong Park. Supervision: JooYong Park. Writing—original draft: Yea-Ju Jin, JooYong Park. Writing—review & editing: JooYong Park.

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