Depression, Anxiety and Associated Factors Among Korean Adolescent Students During COVID-19

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Objectives: Depression and anxiety are emotional difficulties that are common among adolescents. Adolescents suffering from depression and anxiety can exhibit problems such as antisocial behavior, aggression, and academic slump. This study aimed to explore the factors influencing adolescents' depression and anxiety during the coronavirus disease 2019 (COVID-19) pandemic.
Methods: This study examined the data from an online student health survey conducted by the Ministry of Education in 2022. The survey participants were 131194 students ranging from the first grade of middle school to the third grade of high school. The influence of each variable on depression and anxiety was examined.
Results: Factors that predicted depression and anxiety were sex (female), grade level (higher), financial difficulties (existing or unknown), physical activity (higher), sleep time (shorter), media usage time (higher), family/friends relationship (worse), and change in the health status of family, friends, and oneself due to COVID-19 (worse).
Conclusion: These results may help identify patterns of depression and anxiety among adolescents caused by COVID-19 and maximize the intervention effect.

Keywords: Adolescent; Students; Depression; Anxiety; COVID-19 pandemic.

INTRODUCTION

Several years after its outbreak in 2019, the coronavirus disease 2019 (COVID-19) continued to remain active until 2022. COVID-19 is an infectious respiratory disease caused by severe acute respiratory syndrome coronavirus 2; individuals who contract the virus may develop mild-to-severe respiratory disease or even spontaneously recover without treatment [1]. The US Centers for Disease Control and Prevention reported that COVID-19 is primarily transmitted through droplets or the virus coming into contact with certain parts of the body, such as the hands, eyes, nose, and mouth. Consequently, social distancing measures were heightened to minimize interpersonal contact as a key strategy against the spread of the virus.

According to the Korea Disease Control and Prevention Agency, as of November 2022, individuals under the age of 19 years accounted for 23.6% of all COVID-19 cases, totaling 6170949 confirmed cases [2]. To prevent the spread of COVID-19 among adolescents, South Korea has implemented educational policies such as remote learning, shortened classes, and self-diagnosis applications for students [3]. During the early stages of the pandemic, fear of the new infectious disease and its rapid transmission led to stigmatization and social prejudice against COVID-19 patients [4], who were reported to experience negative symptoms, such as high levels of stress, poor sleep quality, and decreased concentration [5].

Depression and anxiety are the most prevalent emotional difficulties faced by adolescents. Adolescence is a period characterized by physical, cognitive, and social growth and development, as well as psychological instability and difficulties in emotional regulation. Adolescents with depression and anxiety turn to aggressive resolutions during conflicts and exhibit externalizing problems as defense mechanisms against sorrow and pain [6]. Furthermore, adolescents who attempt suicide often experience depression and anxiety [7].

Moreover, social isolation, a unique consequence of COVID-19, has exacerbated its negative impact on adolescents' mental health. Factors affecting adolescent depression and

anxiety can be divided into personal factors, daily life, social relationships, and health perceptions. Depression has been reported to increase with female sex, higher school grade levels, age, and lower household income [8]. Parents can serve as valuable resources for mitigating stress in adolescents; however, factors such as parental job loss, mental health issues, and substance abuse can reduce parents' ability to effectively buffer stress in their adolescent children [9]. The challenges faced by parents during the COVID-19 pandemic may directly and indirectly influence their adolescent children, ultimately negatively impacting their mental health. In this context, schoolteachers play an important role in identifying and intervening in factors that could affect students' daily lives and maladjustment, in addition to their roles as academic instructors [10]. Nevertheless, reduced school attendance and diminished physical contact during the few in-person school days due to COVID-19 prevention guidelines hinder early intervention in students' stressors. Furthermore, escalated social isolation stemming from the COVID-19 pandemic has been identified as a significant risk factor for depression and anxiety in children and adolescents, highlighting the need for continued attention and monitoring in this area [11].

Self-rated health (SRH) refers to an individual's objective and subjective evaluation of their health and encompasses their perceived physical, social, and mental health. SRH is reported to be a predictor of health, as individuals may engage in behaviors to manage and maintain their health depending on their SRH [12]. SRH is influenced by individuals' emotions, values, and attitudes and is used as a predictor of morbidity, mortality, school dropout, stress, depressive mood, and happiness [13,14]. Furthermore, negative emotions (worrying, fear, and stress) may also decrease, as individuals who perceive themselves to be healthier consider themselves to be at a low risk of COVID-19 infection. In other words, SRH may affect an individual's emotional response through the mediation of perceived susceptibility (possibility of contracting the infection) during the COVID-19 pandemic, necessitating an examination of the effects of SRH on depression and anxiety [15].

Studies on adolescents' mental health and changes in daily living because of the COVID-19 pandemic have reported that health behavior-related factors such as smoking, drinking, physical inactivity, skipping breakfast, elevated stress [16], and increased family economic hardship have led to depression in adolescents, adversely affecting their mental health [17]. Nevertheless, there is a dearth of studies that utilize a comprehensive approach to identify the factors of daily life that influence adolescents' emotions, with only a few studies examining the levels of depression and anxiety among adolescents because of COVID-19 [18].

Therefore, this study employed a comprehensive approach to investigate personal, daily life, social relationships, and SRH factors that predict depression and anxiety in adolescents using Health Behavior Survey (HBS) data.

METHODS

Participants

We used data from the "COVID-19 Health Behavior Survey" conducted by the Ministry of Education in February 2022 [19]. The HBS is an online self-report questionnaire survey conducted with 341412 5th–12th graders and parents of 1st–4th graders to examine students' health-related characteristics. In the present study, we analyzed data from 131194 7th–12th graders who completed the General Anxiety Disorder-7 (GAD-7) and Patient Health Questionnaire-9 (PHQ-9) for anxiety and depression, respectively.

Instruments

The questionnaire used in the "COVID-19 Health Behavior Survey" comprised 53 items about COVID-19 diagnosis, self-quarantine experiences, family life, relationships with friends, and physical and mental health. This study used 28 items for personal factors, daily life factors, social relationship factors, and SRH.

Personal factors

Personal factors included sex, grade level, financial hardship due to COVID-19, and a history of COVID-19 diagnosis (including self-quarantine). Financial hardship due to COVID-19 was assessed using the question, "Has your family suffered financial hardship due to COVID-19?" The response options were yes, no, I do not know, and the responses were dummy coded with reference to "yes" (1). The history of self-quarantine was assessed using the question, "Have you ever been quarantined due to COVID-19?" Responses were dummy-coded as no (0) or yes (1). Dummy coding is a method for converting categorical variables that are difficult to handle numerically into binary variables (0 or 1) to preserve their relative size or order.

Daily life factors

Daily life factors included those that may affect depression and anxiety, namely physical activity, sleep duration, and changes in media usage (Internet and smartphones). Physical activity was assessed using the question, "How many days a week do you engage in exercise that makes you breathless or sweat for 30 minutes to 1 hour or more?" The responses were "Almost none" (1), "1–2 days" (2), "3–4 days" (3), or "≥5 days" (4). Sleep duration was assessed using the question,

"How many hours do you usually sleep a day?" The responses were "<4 hours" (1), "4–6 hours" (2), "6–8 hours" (3), or "≥8 hours" (4). Changes in media (Internet and smartphone) usage were assessed using the question "Compared to before the COVID-19 outbreak, has your screentime (using the Internet and smartphone, excluding online class time) changed?" The responses were "decreased significantly" (1), "decreased slightly" (2), "no change" (3), "increased slightly" (4), or "increased significantly" (5).

Social relationship factors

Social relationship factors included the factors pertinent to changes in adolescents' relationships with their human resources (family, friends, and teachers) because of the COVID-19 pandemic. The questions are phrased as "Has your relationship with your (family, friends, and teachers separately) changed compared to before the COVID-19 pandemic?" Each item is rated on a 5-point Likert scale from 1 to 5, that is, "deteriorated significantly" (1) to "improved significantly" (5).

Self-rated health factors

SRH asks about one's perception of health status that has changed since a particular time point or event [20]. In the present study, SRH factors included the participants' perceptions of any changes in their family's, friends' or own health due to COVID-19. First, their perception of changes in their family's health was surveyed using the question, "Has your family developed any physical or mental health problems due to COVID-19?" The response options were yes, no, or I do not know and were dummy coded with reference to "no" (1). Their perception of changes in their friends' health was surveyed using the question, "Have your friends developed any physical or mental health problems due to COVID-19?" The response options were yes, no, or I do not know and were dummy coded with reference to "no" (1). Their perception of changes in their own health was surveyed using the question, "How would you rate your own health compared to that before COVID-19?" The question was rated on a 5-point Likert scale from 1 to 5, that is, "deteriorated significantly" (1) to "improved significantly" (5).

Depression and anxiety

Depression and anxiety were the dependent variables. Depression was assessed using the Korean version of the PHQ-9 adapted by An et al. [21]. The PHQ-9 contains nine items, and the total score is used to assess the severity of depression. The questionnaire asked about the frequency of problems experienced in the past two weeks. Each item is rated on a 5-point scale from "never" (0) to "almost every day" (4). In this study, the internal consistency and reliability of the

PHQ-9 was good with Cronbach α of 0.89.

Anxiety was assessed using the GAD-7. Each of the seven items of this self-report questionnaire is rated on a 4-point scale from "not at all" (0) to "almost every day" (3). Individuals who score 10 or higher are diagnosed with GAD. In the present study, the internal consistency reliability (Cronbach α) was 0.92.

Data analysis

This study was approved by the Institutional Review Board (IRB) of Uijeongbu St. Mary's Hospital of the Catholic University (UC22ZESE0114). The search data was collected

Table 1. Common background of research subjects

Variable	Value
Sex	
Female	76764 (58.5)
Male	54430 (41.5)
Level of school	
Middle school	79880 (60.9)
High school	51314 (39.1)
Economic hardship due to COVID-19	
None	82989 (63.3)
Exist	16855 (12.8)
Not knowing	31350 (23.9)
COVID-19 confirmed experience	
None	125448 (95.6)
Exist	5746 (4.4)
Physical activity*	
Almost never	69717 (53.1)
About 1–2 days	29441 (22.4)
About 3–4 days	15972 (12.2)
More than 5 days	16064 (12.2)
Sleep time	
Within 4 hours	4749 (3.6)
4–6 hours	17796 (13.5)
6–8 hours	57887 (44.1)
More than 8 hours	50789 (38.7)
Depressed	
Normal	92641 (70.6)
Mild depression	22538 (17.2)
Moderate depression	13196 (10.1)
Severe depression	2819 (2.1)
Anxiety	
Normal	107808 (82.2)
Mild anxiety	14234 (10.8)
Moderate anxiety	5418 (4.1)
Severe anxiety	3734 (2.8)

Data are presented as n (%). *the number of days in which you exercised for at least 30 minutes to 1 hour per day to the extent that you were out of breath or sweated for 1 week. COVID-19, coronavirus disease 2019

from a national public institution, this study was exempt from informed consent. The collected data were analyzed using SPSS 27.0 (IBM Corp., Armonk, NY, USA), and the following statistical analyses were performed. First, the participants' general characteristics were analyzed using frequency analysis. Second, the differences in depression and anxiety according to personal factors were analyzed using t-tests and analysis of variance, followed by Scheffé's test for post-hoc comparisons. Third, the effects of adolescents' individual, daily life, social relationships, and SRH factors on depression and anxiety were analyzed using multiple regression.

RESULTS

Participants' general background

The general background of the study participants is shown in Table 1. A total of 131194 middle and high school students were enrolled in the study. The student population comprised 58.5% females and 41.5% males, and there were more middle school students (60.9%) than high school students (39.1%). Most students did not face financial hardship from COVID-19 (63.3%), while 12.8% did have financial hardship from

COVID-19, with 23.9% answering "I do not know." The vast majority (95.6%) of the adolescents had never been quarantined, while 4.4% had been quarantined.

As for physical activity, most adolescents chose "almost none" (53.1%), followed by 1–2 days (22.4%), 3–4 days (12.2%), and ≥5 days (12.2%). The most common sleep duration was 6–8 hours (44.1%), followed by ≥8 hours (38.7%), 4–6 hours (13.5%), and <4 hours (3.6%).

Regarding depression, most had no depression (70.6%), followed by mild (17.2%), depression (10.1%), and severe depression (2.1%). Most participants had no anxiety (82.2%), followed by those with mild (10.8%), moderate (4.1%), and severe anxiety (2.8%).

Depression and anxiety according to general background

Table 2 shows the differences in depression according to the adolescents' general background (Table 2). There were significant differences in depression according to sex (p<0.001), school grade level (p<0.001), financial hardship due to COVID-19 (p<0.001), history of COVID-19 diagnosis (p<0.01), physical activity (p<0.001), and sleep duration (p<0.001). First,

Table 2. Differences in depression according to general background

Variable	Total	Value	t/F (Scheffé)	Post hoc (Scheffé)
Sex			-47.18***	
Female	76764	4.23±5.35		
Male	54430	2.90±4.75		
Level of school			-30.02***	
Middle school	79880	3.33±4.89		
High school	51314	4.22±5.49		
Economic hardship due to COVID-19			3943.06***	a<b<c
None	82989	2.79±4.35[a]		
Exist	16855	6.12±6.69[c]		
Not knowing	31350	4.69±5.54[b]		
COVID-19 confirmed experience[†]			-3.16**	
None	125448	3.67±5.15		
Exist	5746	3.89±5.32		
Physical activity			260.86***	a<b<c<d
Almost never	69717	4.04±5.38[d]		
About 1–2 days	29441	3.14±4.62[a]		
About 3–4 days	15972	3.30±4.87[b]		
More than 5 days	16064	3.46±5.21[c]		
Sleep time			788.64***	a<b<c<d
Within 4 hours	4749	5.83±7.52[d]		
4–6 hours	17796	4.85±5.84[c]		
6–8 hours	57887	3.16±4.59[a]		
More than 8 hours	50789	3.64±5.11[b]		

Data are presented as mean±standard deviation or numbers only. **p<0.01; ***p<0.001; [†]there is a difference in depression according to the experience of COVID-19 when assuming equal variance in the experience of confirmed COVID-19. COVID-19, coronavirus disease 2019

girls showed higher levels of depression (4.23, standard deviation [SD]=5.35) than boys (2.90, SD=4.75), and high school students showed higher levels of depression (4.22, SD=5.49) than middle school students (3.33, SD=4.89). In terms of financial hardship because of COVID-19, the mean depression score was the highest among students who answered "yes" (6.12, SD=6.69), followed by "I do not know" (4.69, SD=5.54) and "no" (2.79, SD=4.35) (F=3943.06, p<0.001). Students who had been diagnosed with COVID-19 had higher depression scores (3.89, SD=5.32) than those who had never been diagnosed with COVID-19 (3.67, SD=5.15). Students who almost never engaged in the exercise had the highest depression score (4.04, SD=5.38), which varied significantly across the different physical activity groups (F=260.86, p<0.001). Students who slept for less than four hours had the highest depression score (5.83, SD=7.52), and the depression score tended to decrease with increasing sleep duration.

Table 3 shows the differences in anxiety according to adolescents' general backgrounds. There were significant differences in depression according to sex (p<0.001), school grade level (p<0.001), financial hardship because of COVID-19 (p<0.001), history of COVID-19 diagnosis (p<0.01), physical

activity (p<0.001), and sleep duration (p<0.001). First, girls had a higher level of anxiety (2.65, SD=4.27) than boys (1.76, SD=3.72), and high school students tended to show a higher level of anxiety (2.64, SD=4.39) than middle school students (2.06, SD=3.84). In terms of financial hardship from COVID-19, the mean anxiety score was the highest among students who answered "yes" (4.12, SD=5.45), followed by "I do not know" (2.92, SD=4.42) and "no" (1.67, SD=3.40) (F=3200.42, p<0.001). Students who had been diagnosed with COVID-19 had higher depression scores (2.29, SD=4.70) than those who had never been diagnosed with COVID-19 (2.17, SD=4.18). Students who engaged in physical activity 1−2 days a week had the lowest anxiety scores (1.95, SD=3.64), and the anxiety scores varied significantly across the different physical activity groups (F=153.62, p<0.001). Students who slept for less than four hours had the highest anxiety score (3.74, SD=5.98), which tended to decrease with increasing sleep duration.

Correlations among variables

Depression in adolescents was negatively correlated with physical activity; sleep duration; changes in family, friends, and teacher relationships; and changes in SRH, but positively

Table 3. Differences in anxiety according to general background

Variable	Total	Value	t/F (Scheffé)	Post hoc (Scheffé)
Sex			-40.30***	
Female	76764	2.65±4.27		
Male	54430	1.76±3.72		
Level of school			-24.55***	
Middle school	79880	2.06±3.84		
High school	51314	2.64±4.39		
Economic hardship due to COVID-19			3200.42***	a<b<c
None	82989	1.67±3.40[a]		
Exist	16855	4.12±5.45[c]		
Not knowing	31350	2.92±4.42[b]		
COVID-19 confirmed experience[†]			2.13**	
None	125448	2.29±4.70		
Exist	5746	2.17±4.18		
Physical activity			153.62***	a<b<c
Almost never	69717	2.50±4.26[c]		
About 1−2 days	29441	1.95±3.64[a]		
About 3−4 days	15972	2.06±3.82[b]		
More than 5 days	16064	2.15±4.14[b]		
Sleep time			573.15***	a<b<c
Within 4 hours	4749	3.74±5.98[c]		
4−6 hours	17796	3.15±4.78[b]		
6−8 hours	57887	2.04±3.68[a]		
More than 8 hours	50789	2.13±3.94[a]		

Data are presented as mean±standard deviation or numbers only. **p<0.01; ***p<0.001; [†]there is a difference in anxiety according to the experience of COVID-19 when assuming equal variance in the experience of confirmed COVID-19. COVID-19, coronavirus disease 2019

Table 4. Correlation between depression variables

Variable	Physical activity	Sleep time	Changes in media usage time	Change in family relationships	Change in friendship	Changes in teacher relationships	Subjective state of health	Depressed
Physical activity†								
Sleep time†	0.018***							
Changes in media usage time‡	-0.103***	0.053***						
Change in family relationships‡	0.049***	0.030***	-0.102***					
Change in friendship‡	0.060***	0.008***	-0.168***	0.201***				
Changes in teacher relationships‡	0.060***	0.013***	-0.194***	0.160***	0.310***			
Subjective state of health‡	0.180***	0.033***	-0.283***	0.176***	0.234***	0.206***		
Depressed	-0.053***	-0.080***	0.227***	-0.159***	-0.169***	-0.128***	-0.334***	
M±SD	1.83±1.05	3.17±0.79	3.81±0.83	3.04±0.60	2.91±0.61	2.91±0.48	2.70±0.68	3.68±5.15

***$p < 0.001$; †physical activity and sleep time on a 4-point scale; ‡changes in media (Internet and smartphone) usage time, changes in family relationships due to COVID-19, changes in friends relationships due to COVID-19, changes in relationships with teachers due to COVID-19, and subjective health changes compared to before the outbreak of COVID-19 were scored as 5 points standard. COVID-19, coronavirus disease 2019; M, mean; SD, standard deviation

correlated with changes in media usage. In other words, adolescents with less physical activity, shorter sleep duration, poorer family relationships, poorer friend relationships, poorer teacher relationships, poorer SRH, and higher media usage exhibited higher levels of depression (Table 4).

The results for anxiety were similar between the groups. It was negatively correlated with physical activity; sleep duration; changes in family, friend, and teacher relationships; and changes in SRH, but positively correlated with changes in media usage. In other words, adolescents with less physical activity, shorter sleep duration, poorer family relationships, poorer friend relationships, poorer teacher relationships, poorer SRH, and higher media usage exhibited higher levels of anxiety (Table 5).

Predictors of depression among adolescents

The effects of individual, daily life, social relationships, and SRH factors on depression and anxiety were analyzed using hierarchical regression. In model 1, we included adolescents' personal factors (sex, grade level, financial hardship, and history of COVID-19 diagnosis). In model 2, we included adolescents' daily life factors (physical activity, sleep duration, and changes in media usage). In model 3, we included social relationship factors (changes in family, friend, and teacher relationships due to COVID-19). Finally, in model 4, we included the SRH factors (changes in family's, friends' and one's own health compared to pre-COVID-19).

Table 6 shows the effects of adolescents' individual, daily life, social relationships, and SRH factors on depression. First, in model 1, sex (β=0.11, p<0.001), grade level (β=0.10, p<0.001), financial hardship due to COVID-19 (β=0.20, p<0.001), unknown financial hardship from COVID-19 (β=0.14, p<0.001), and history of COVID-19 diagnosis (β=0.01, p<0.01) significantly predicted depression. Model 1 explained for 8.1% (F= 2318.94, p<0.01) of the variance.

In model 2, physical activity, sleep duration, and changes in media usage (Internet and smartphone) were included, and model 2 explained 12% of the variance (F=2242.38, p< 0.001). Sex (β=0.09, p<0.001), grade level (β=0.10, p<0.001), financial hardship due to COVID-19 (β=0.17, p<0.001), unknown financial hardship from COVID-19 (β=0.13, p<0.001), history of COVID-19 diagnosis (β=0.01, p<0.001), sleep duration (β=-0.07, p<0.001), and changes in media usage (Internet and smartphone) (β=0.19, p<0.001) were identified as significant predictors of depression.

In model 3, changes in family relationship due to COVID-19, changes in friend relationship due to COVID-19, and changes in teacher relationships due to COVID-19 were included, and the percentage of the explained variance increased to approximately 14.2% (F=1975.40, p<0.001). Sex (β=0.09,

Table 5. Correlation between anxiety variables

Variable	Physical activity	Sleep time	Changes in media usage time	Change in family relationships	Change in friendship	Changes in teacher relationships	Subjective state of health	Anxiety
Physical activity[†]								
Sleep time[†]	0.018***							
Changes in media usage time[‡]	-0.103***	0.053***						
Change in family relationships[‡]	0.049***	0.030***	-0.102***					
Change in friendship[‡]	0.060***	0.008***	-0.168***	0.201***				
Changes in teacher relationships[‡]	0.060***	0.013***	-0.194***	0.160***	0.310***			
Subjective state of health[‡]	0.180***	0.033***	-0.283***	0.176***	0.234***	0.206***		
Anxiety	-0.041***	-0.087***	0.204***	-0.154***	-0.168***	-0.126***	-0.298***	
M±SD	1.83±1.05	3.17±0.79	3.81±0.83	3.04±0.60	2.91±0.61	2.91±0.48	2.70±0.68	2.28±4.07

***p<0.001; [†]physical activity and sleep time on a 4-point scale; [‡]changes in media (Internet and smartphone) usage time, changes in family relationships due to COVID-19, changes in friends relationships due to COVID-19, changes in relationships with teachers due to COVID-19, and subjective health changes compared to before the outbreak of COVID-19 were scored as 5 points standard. COVID-19, coronavirus disease 2019; M, mean; SD, standard deviation

p<0.001), grade level (β=0.10, p<0.001), financial hardship due to COVID-19 (β=0.15, p<0.001), unknown financial hardship from COVID-19 (β=0.12, p<0.001), history of COVID-19 diagnosis (β=0.01, p<0.001), physical activity (β=0.01, p<0.01), sleep duration (β=-0.06, p<0.001), changes in media usage (Internet and smartphone) (β=0.16, p<0.001), changes in family relationship due to COVID-19 (β=-0.09, p<0.001), changes in friend relationship due to COVID-19 (β=-0.08, p<0.001), and changes in teacher relationship due to COVID-19 (β= -0.02, p<0.001) were identified as significant predictors of depression.

In model 4, the SRH factors were included, and the percentage of explained variance increased to approximately 23.9% (F=2581.31, p<0.001). Sex (β=0.09, p<0.001), grade level (β=0.08, p<0.001), financial hardship due to COVID-19 (β= 0.06, p<0.001), unknown financial hardship from COVID-19 (β=0.02, p<0.001), physical activity (β=0.03, p<0.001), sleep duration (β=-0.05, p<0.001), changes in media usage (Internet and smartphone) (β=0.09, p<0.001), changes in family relationship due to COVID-19 (β=-0.05, p<0.001), changes in friend relationship due to COVID-19 (β=-0.04, p<0.001), changes in teacher relationship due to COVID-19 (β=0.01, p<0.001), changes in family's health due to COVID-19—yes (β=0.15, p<0.001), changes in family's health due to COVID-19—I do not know (β=0.15, p<0.001), changes in friend's health due to COVID-19—yes (β=0.11, p<0.001), changes in friend's health due to COVID-19—I do not know (β=0.05, p< 0.001), and changes in SRH compared to pre-COVID-19 (β= -0.19, p<0.001) were identified as significant predictors of depression.

Predictors of anxiety among adolescents

Table 7 shows the effects of individual, daily life, social relationships, and SRH factors on anxiety among adolescents. In model 1, sex (β=0.09, p<0.001), grade level (β=0.08, p<0.001), financial hardship due to COVID-19 (β=0.19, p<0.001), unknown financial hardship from COVID-19 (β=0.12, p<0.001), and history of COVID-19 diagnosis (β=-0.01, p<0.05) significantly predicted anxiety, with approximately 6.4% of variance explained (F=1780.37, p<0.01).

In model 2, physical activity, sleep duration, and changes in media usage (Internet and smartphone) were included, and the model explained 9.7% of the variance (F=1769.23, p<0.001). Sex (β=0.08, p<0.001), grade level (β=0.08, p<0.001), financial hardship due to COVID-19 (β=0.16, p<0.001), unknown financial hardship from COVID-19 (β=0.10, p<0.001), physical activity (β=0.00, p<0.001), sleep duration (β=-0.08, p<0.001), and changes in media usage (Internet and smartphone) (β=0.17, p<0.001) were identified as significant predictors of anxiety.

Table 6. Factors influencing depression in adolescents (n=131194)

Variable	Model 1				Model 2				Model 3				Model 4			
	B	SE	β	t	B	SE	β	t	B	SE	β	t	B	SE	β	t
Demographic factors																
Sex†	1.21	0.02	0.11	43.77***	1.03	0.02	0.09	37.49***	1.03	0.02	0.09	37.89***	0.93	0.02	0.09	36.53***
Grade	0.32	0.01	0.10	39.19***	0.31	0.01	0.10	38.64***	0.31	0.01	0.10	39.02***	0.27	0.01	0.08	35.91***
Economic hardship due to COVID-19 (1=exist)	3.20	0.04	0.20	76.62***	2.70	0.04	0.17	65.16***	2.37	0.04	0.15	57.41***	1.03	0.04	0.06	25.26***
Economic hardship due to COVID-19 (1=not knowing)	1.79	0.03	0.14	54.78***	1.59	0.03	0.13	49.57***	1.46	0.03	0.12	46.01***	0.32	0.03	0.02	9.69***
COVID-19 confirmed experience (1=exist)	0.20	0.06	0.01	2.99**	0.29	0.06	0.01	4.54***	0.33	0.06	0.01	5.15***	0.05	0.06	0.01	0.86
Daily life factors																
Physical activity					-0.01	0.01	0.00	-0.11	0.03	0.01	0.01	2.91**	0.14	0.01	0.03	12.08***
Sleep time					-0.46	0.01	-0.07	-27.61***	-0.43	0.01	-0.06	-26.07***	-0.33	0.01	-0.05	-20.90***
Changes in media usage time					1.18	0.01	0.19	72.16***	1.03	0.01	0.16	62.22***	0.59	0.01	0.09	37.34***
Social relationship factors																
Changes in family relationships due to COVID-19									-0.82	0.02	-0.09	-36.87***	-0.46	0.02	-0.05	-21.53***
Changes in friendship due to COVID-19									-0.73	0.02	-0.08	-31.83***	-0.39	0.02	-0.04	-18.22***
Changes in relationships with teachers due to COVID-19									-0.25	0.02	-0.02	-8.83***	0.10	0.02	0.01	3.71***
Subjective health factors																
Changes in family health due to COVID-19 (1=having a health problem)													3.32	0.05	0.15	57.18***
Changes in family health due to COVID-19 (1=not knowing)													1.93	0.03	0.15	56.75***
Changes in health problems of friends due to COVID-19 (1=having health problems)													1.77	0.03	0.11	46.16***
Changes in health problems of friends due to COVID-19 (1=not knowing)													0.62	0.03	0.05	19.89***
Subjective state of health change before the outbreak of COVID-19													-1.45	0.02	-0.19	-71.53***
ΔR²							0.039				0.022				0.097	
R²			0.081				0.120				0.142				0.239	
F			2318.93**				2242.38***				1975.40***				2581.31***	

**p<0.01; ***p<0.001; †sex: male=0, female=1. Durbin–Watson=1.988. COVID-19, coronavirus disease 2019; SE, standard error

Table 7. Factors influencing anxiety in adolescents (n=131194)

Variable	Model 1				Model 2				Model 3				Model 4			
	B	SE	β	t	B	SE	β	t	B	SE	β	t	B	SE	β	t
Individual factors																
Sex†	0.81	0.02	0.09	36.80***	0.69	0.02	0.08	31.41***	0.69	0.02	0.08	31.66***	0.63	0.02	0.07	30.28***
Grade	0.20	0.01	0.08	31.60***	0.19	0.01	0.08	30.18***	0.19	0.00	0.08	30.42***	0.16	0.00	0.06	27.20***
Economic hardship due to COVID-19 (1=exist)	2.37	0.03	0.19	71.22***	2.02	0.03	0.16	60.85***	1.75	0.03	0.14	52.99***	0.74	0.03	0.06	22.44***
Economic hardship due to COVID-19 (1=not knowing)	1.18	0.02	0.12	45.36***	1.04	0.02	0.10	40.54***	0.94	0.02	0.09	36.91***	0.11	0.02	0.01	4.37***
COVID-19 confirmed experience (1=exist)	-0.13	0.05	-0.01	-2.55*	-0.06	0.05	-0.00	-1.27	-0.03	0.05	-0.00	-0.72	-0.24	0.04	-0.01	-5.02***
Daily life factors																
Physical activity					0.02	0.01	0.00	2.03***	0.05	0.01	0.01	5.12***	0.12	0.01	0.03	12.81***
Sleep time					-0.42	0.01	-0.08	-31.12***	-0.39	0.01	-0.07	-29.63***	-0.32	0.01	-0.06	-25.08***
Changes in media usage time					0.84	0.01	0.17	64.22***	0.71	0.01	0.14	54.06***	0.41	0.01	0.08	31.62***
Social relationship factors																
Changes in family relationships due to COVID-19									-0.63	0.01	-0.09	-35.26***	-0.36	0.01	-0.05	-20.89***
Changes in friendship due to COVID-19									-0.60	0.01	-0.09	-33.11***	-0.37	0.01	-0.05	-20.94***
Changes in relationships with teachers due to COVID-19									-0.23	0.02	-0.02	-10.17***	0.02	0.02	0.00	1.11
Subjective health factors																
Changes in family health due to COVID-19 (1=having a health problem)													2.80	0.04	0.16	59.57***
Changes in family health due to COVID-19 (1=not knowing)													1.44	0.02	0.14	52.21***
Changes in health problems of friends due to COVID-19 (1=having health problems)													1.22	0.03	0.10	39.28***
Changes in health problems of friends due to COVID-19 (1=not knowing)													0.38	0.02	0.04	15.36***
Subjective state of health change before the outbreak of COVID-19													-0.97	0.01	-0.16	-59.51***
ΔR²					0.034				0.023				0.082			
R²	0.064				0.097				0.120				0.202			
F	1780.37**				1769.23***				1626.48***				2081.56***			

*p<0.05; **p<0.01; ***p<0.001; †sex: male=0, female=1. Durbin–Watson=1.988. COVID-19, coronavirus disease 2019; SE, standard error

In model 3, changes in family relationships due to COVID-19, changes in friend relationships due to COVID-19, and changes in teacher relationships due to COVID-19 were included, and the percentage of explained variance increased to approximately 12.0% (F=1626.48, p<0.001). Sex (β=0.08, p<0.001), grade level (β=0.08, p<0.001), financial hardship due to COVID-19 (β=0.14, p<0.001), unknown financial hardship from COVID-19 (β=0.09, p<0.001), physical activity (β=0.01, p<0.001), sleep duration (β=-0.07, p<0.001), changes in media usage (Internet and smartphone) (β=0.14, p<0.001), changes in the family relationship due to COVID-19 (β=-0.09, p<0.001), changes in friend relationship due to COVID-19 (β=-0.09, p<0.001), and changes in teacher relationship due to COVID-19 (β=-0.02, p<0.001) were identified as significant predictors of anxiety.

In model 4, SRH factors were included, and the percentage of variance explained increased to approximately 20.2% (F=2081.56, p<0.001). Sex (β=0.07, p<0.001), grade level (β=0.06, p<0.001), financial hardship due to COVID-19 (β=0.06, p<0.001), unknown financial hardship from COVID-19 (β=0.01, p<0.001), history of COVID-19 diagnosis (β=-0.01, p<0.001), physical activity (β=0.03, p<0.001), sleep duration (β=-0.06, p<0.001), changes in media usage (Internet and smartphone) (β=0.08, p<0.001), changes in family relationship due to CO-VID-19 (β=-0.05, p<0.001), changes in friend relationship due to COVID-19 (β=-0.05, p<0.001), changes in family's health due to COVID-19—yes (β=0.16, p<0.001), changes in family's health due to COVID-19—I do not know (β=0.14, p<0.001), changes in friend's health due to COVID-19—yes (β=0.10, p<0.001), changes in friend's health due to COVID-19—I do not know (β=0.04, p<0.001), and changes in SRH compared to pre-COVID-19 (β=-0.16, p<0.001) were identified as significant predictors of anxiety.

DISCUSSION

This study investigated the effects of COVID-19 on depression and anxiety among adolescents in terms of their personal, daily life, social relationships, and SRH factors. The results showed that the levels of depression and anxiety were higher among girls with higher grade levels and financial hardship in the family (compared to those who do not know about or those who do not have financial hardship). Furthermore, they were higher among girls with more frequent physical activity, shorter sleep duration, longer media usage (Internet and smartphone), poorer family and friend relationships due to COVID-19, deterioration of family health or friend health, lack of awareness thereof, and worsened SRH compared to the pre-COVID-19 period. However, depression increased with closer relationships with teachers compared to

the pre-COVID-19 period.

In our study, the levels of depression and anxiety differed significantly according to sex, school grade level, financial hardship, history of COVID-19 diagnosis, degree of physical activity, and sleep duration. Chen et al. [22], also reported that the rates of depression and anxiety were higher among girls than boys with higher grade levels and among those who did not engage in regular physical activity. Moreover, Lee and Ji [23] reported that regular physical activity enhances self-esteem and consequently reduces depression and suicidal ideation. Improved mental health promotes positive activities in daily life such as relationships with peers and families. In particular, restrictions on activities in limited spaces within the home hinder students' emotional growth and development and are anticipated to contribute to difficulties in fostering various relationships. In a study of 1009 adolescents aged 10−17 years, Chung et al. [24] reported that sleep duration among adolescents has increased since the outbreak of COVID-19, but that sleep quality deteriorated as more students went to bed after midnight. Further, the group that slept for the recommended duration exhibited greater levels of happiness than the group that slept too much, in line with our findings.

Parental job loss because of the COVID-19 pandemic has had a detrimental effect on the mental well-being of adolescents [25]. Moreover, more economically disadvantaged groups such as low-income individuals, less-educated individuals, and women tend to have lower household incomes. Hence, adolescents from economically disadvantaged households are expected to experience higher levels of depression and anxiety.

The history of COVID-19 diagnosis had varying effects on depression and anxiety. Although it did not predict depression, students with a history of COVID-19 diagnosis displayed higher levels of anxiety than those who had never been diagnosed with COVID-19. This finding suggests that uncontrollable worries and fears escalate anxiety. In other words, children may be subject to more intense fear as they are exposed to cases of exacerbated COVID-19 infection through the mass media or people around them.

The COVID-19 pandemic has revealed that depression tends to increase among adolescents as family and peer relationships deteriorate [26]. Families and friends are also important sources of social support for students. During adolescence, individuals learn social skills and norms through diverse relationships. Adolescents acquire rules and standards for adulthood as they interact with others and establish their identities through positive interpersonal relationships. Individuals who perceive higher levels of social support tend to experience greater psychological stability [27]. To al-

leviate the depression and anxiety experienced by adolescents in the context of COVID-19, it is necessary to secure social support resources from adolescents' social networks, such as family and peers.

When SRH factors (perceived health of family, friends, and themselves) were included, the level of depression increased among students who grew closer to their teachers. This is contradictory to previous findings in which a supportive student-teacher relationship served as a protective factor against depression in students [28]. Adolescents are particularly sensitive to peer evaluation, and the absence of support and acceptance from their surroundings may result in emotional distress and confusion [29]. Students had fewer opportunities to interact and bond with their teachers amid the prolonged use of online learning platforms during the COVID-19 pandemic. Consequently, it is plausible that students who perceive themselves, their family, and friends to be in poor health may experience amplified pressure to fulfill positive expectations in their relationships with their teachers, ultimately leading to elevated levels of depression.

SRH is one of the most widely used quality of life indicators. Perceiving changes in their own health as well as the health of their friends and family, which are important resources for adolescents compared to the pre-COVID-19 period, predicted the level of depression and anxiety in adolescents. Fitzpatrick et al. [30] reported that the number of COVID-19 cases in a community is positively associated with internalizing problems among children and adolescents. This suggests that adolescents' concerns about the possibility of infecting others during quarantine, uncertainty about COVID-19, disruptions to their daily lives, and the well-being of their loved ones during the COVID-19 pandemic are linked to their mental health [29]. Moreover, depression and anxiety resulting from an awareness of one's own and their loved ones' health status are in line with the "paradox of disability" theory [31]. This theory suggests that individuals with disabilities or illnesses who lead high-quality lives perceive their health more positively and well-manage their illness [32,33]. This implies that perception of health is an important predictor of depression and anxiety in adolescents.

One key significance of this study is that it is a large-scale study that comprehensively examined personal and daily life, social relationships, and SRH-related risk factors for depression and anxiety in students. However, this study has some limitations. First, the survey was conducted approximately two years after the outbreak of COVID-19, when social distancing measures were mostly lifted and students resumed in-person learning in school. We could not control for the potential impact of such a social atmosphere on depression and anxiety among adolescents. Controlling for this potential confounding effect would require a longitudinal study to compare the early COVID-19 period and the current time point, and an additional item asking about any treatments for depression and anxiety should be added.

Second, the results for depression and anxiety among the adolescents showed similar trends, suggesting that a considerable number of students had comorbid depression and anxiety. Subsequent studies should categorize students based on the presence of depression, anxiety, and both depression and anxiety and identify the characteristics of each group.

Third, after entering the SRH factors, the level of depression increased, with a closer relationship with the teacher, compared to the pre-COVID-19 period. However, little research has been conducted on the associations among SRH, relationships with teachers, and depressive symptoms. Further studies should examine the relationships between these variables and their properties in more detail.

Despite these limitations, various predictors of depression and anxiety among adolescents should be assessed to provide appropriate treatment and intervention. In the event of a disaster such as COVID-19, it is important to provide accurate information about the disaster and promote desirable health perceptions to alleviate anxiety and depression.

CONCLUSION

This study explored the effects of personal, daily life, social relationships, and SRH factors on depression and anxiety due to COVID-19 among adolescents. Our results indicate that depression and anxiety were higher with female sex, higher grade level, financial hardship in family or not knowing about the family's financial hardship (compared to lack of financial hardship in family), higher physical activity, shorter sleep duration, longer media usage (Internet and smartphone), deteriorated family and friend relationships due to COVID-19, deterioration of or not knowing about changes in family's or friends' health due to COVID-19, and poorer SRH compared to the pre-COVID-19 period. Subsequently, studies should classify adolescents' characteristics specifically into groups of depression only, anxiety only, and both depression and anxiety to examine the trends in the impact of COVID-19 on depression and anxiety. Additionally, longitudinal studies are required to compare the early COVID-19 period with the present.

Author Contributions

Conceptualization: all authors. Data curation: Da-young Jung, Kyung Hee Yoon, Yong-Sil Kweon. Formal analysis: Da-young Jung. Funding acquisition: Myeong-yeon Jo. Investigation: Da-young Jung, Kyung Hee Yoon, Yong-Sil Kweon. Methodology: Da-young Jung, Kyung Hee Yoon, Hyun-joo Jeong, Yong-Sil Kweon. Project administration: Myeong-yeon Jo, Hyun-joo Jeong, Yong-Sil Kweon. Resources: Da-young Jung, Kyung Hee Yoon, Myeong-yeon Jo, Hyun-joo Jeong. Software: Da-young Jung. Supervision: Yong-Sil Kweon. Validation: Myeong-yeon Jo, Yong-Sil Kweon. Visualization: Da-young Jung, Yong-Sil Kweon. Writing—original draft: Da-young Jung, Kyung Hee Yoon, Yong-Sil Kweon. Writing—review & editing: all authors.

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