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Physical Activity and Depression among Korean Female College Students Due to COVID-19

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Abstract: College students' physical activity and depression are important factors that can predict physical and psychological health after middle age. In particular, it is necessary to approach these two variables with interest in female college students who show less physical activity and a higher tendency to depression than male students, especially at a time when physical activity is reduced due to COVID-19. The purpose of the study was to investigate the relationship between differences in depression according to the amount of physical activity before and after the COVID-19 pandemic and variables for female college students. A total of 467 students attending colleges in two cities participated in the study. The International Physical Activity Questionnaire and Beck Depression Inventory were used to assess physical activity and depression, respectively. For the analysis, descriptive statistics, reliability analysis, independent *t*-test, one-way ANOVA, and Pearson's correlation analysis were conducted. The results are as follows: first, the total physical activity of female college students decreased, and depression increased due to COVID-19. Second, depression levels differed among female college students according to their level of physical activity before and after the pandemic. Finally, a negative correlation was found between the amount of physical activity and the level of depression among female college students. In conclusion, the amount of physical activity and depression of female college students were judged to be affected by the COVID-19 outbreak, and thereafter, experimental studies to reduce depression in female college students by increasing physical activity are required.

Keywords: post-COVID 19; physical activity; depression; female college students

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1. Introduction

Coronavirus disease 2019 (COVID-19) has rapidly spread worldwide and has significantly impacted various aspects of people's lives, including society, the economy, culture, and education [1]. On 11 March 2020, the World Health Organization declared the onset of the COVID-19 pandemic with the highest level of warning for infectious diseases. Thus, to prevent the spread of infection, Korea implemented social distancing in stages by limiting business hours, banning large-scale events, limiting private gatherings, asking people to refrain from going out, and making masks mandatory [2]. Nevertheless, COVID-19 continues to cause social confusion.

As with other segments of the populace, COVID-19 has affected college students. As part of social distancing, all classes in elementary, middle, and high schools, as well as colleges, across the country were converted into full-scale non-face-to-face classes. Furthermore, as educational and various youth-related institutions implemented social distancing, most teenagers, including college students, experienced sudden changes in the circumstance that increased the amount of time spent at home. Overall, 43.2% of children and adolescents experienced stress due to COVID-19, which lasted for more than two years [2]. Meanwhile, college students experienced difficulties in academic performance

and adaptation due to various changes in their living conditions [3], and the proportion of adolescents requesting psychological counseling increased rapidly [4].

The pandemic has induced fear, isolation, and lethargy, which may lead to depression, anxiety, and stress [5,6]. Prolonged COVID-19 has created "Corona Blue", which means depression caused by COVID-19, and "Corona Red", by which psychological emotions are expressed as anger. Recent studies have shown that the COVID-19 pandemic has increased individuals' anxiety, depression, and post-traumatic stress disorder [1,7–14]. Depression is a dangerous state of mind that heightens one's pessimistic perceptions of the future; it can also lead to suicidal thoughts if intensified [15–18]. Depression among college students is a psychological problem with the highest prevalence rate as well [19]. According to the depression cognitive model, women are more vulnerable to depression than men [20]. Furthermore, depression rapidly increases in adolescents between the ages of 15 and 18, and its prevalence is more than twice as high in women than in men during this period [21]. Therefore, it is necessary to take a close look at the depression in female college students in their early adulthood and attempt to devise an intervention plan.

Physical activity, which is directly related to human psychological health, reduces depression, anxiety, and stress; it can also prevent lifestyle diseases such as obesity, diabetes, cardiovascular disease, and high blood pressure [22–25]. In addition, regular physical activity affects college students' physical self-concept [26] and increases satisfaction with their appearance and physical appearance [27], and eventually, college students' appearance satisfaction has a positive effect on social factors such as job stress, school life adaptation, and interpersonal relationship tendencies [28–30]. To prevent depression in adults, the World Health Organization has recommended participation in at least 150 min of medium-intensity physical activity and 75 min of high-intensity exercise per week. However, more than 60% of people around the globe do not follow these recommendations [31]. In Korea, despite government-level efforts such as the National Physical Fitness 100 Project and the National Health Promotion Comprehensive Plan 2010–2020, the participation of people in physical activities is relatively low compared to those who are in North America and Europe [32]. According to the "national sports participation survey report" announced by the Ministry of Culture, Sports and Tourism (2019), the proportion of women in their 20s who participate in regular physical activity for at least once (30 min or more) a week was 57.5%, which is 3.3% lower than that of men. Also, the proportion of women in their 20s who did not participate in physical activity at all was 35.4%, which was 8.7% higher than that of men (26.7%) [33].

The physical activity habits formed by college students are the main variables that can predict lifestyle and health after graduation. This is because, while at college, a person becomes free of the supervision of parents and teachers [34]. Regular exercise and continuous participation in physical activity have been emphasized as a way to prevent and reduce depression in college students. In fact, preceding studies have suggested that regular exercise participation can prevent or reduce depression [35–38]. In addition, when controlling for variables such as age, gender, education level, and presence of chronic diseases related to the degree of depression, the degree of depression in active people was found to be 20 to 30% lower than that in inactive people [39]. However, most of the preceding studies have verified only the effect of participation in a specific sport event, and have indirectly supported that the amount of physical activity is related to depression. Therefore, the purpose of the study was to examine the changes in physical activity and depression among female college students in 2018 (before COVID-19) and 2020 (after COVID-19). It analyzed the changes in physical activity and depression of female college students due to COVID-19 and the results can be used as a reference for managing physical activity programs and policy; and depression control.

This study aimed to answer the following research questions:

1. To what extent did COVID-19 change the levels of physical activity and depression among Korean female college students?

2. Is there a difference between the levels of physical activity and depression among Korean female college students before and after the COVID-19 outbreak?
3. Was there a correlation between the amount of physical activity and depression among Korean female college students during the COVID-19 outbreak?

2. Methods

2.1. Research Subjects

This cross-sectional study conducted two surveys—one before the occurrence of COVID-19 (2018) and one after (2020). Both the 2018 and 2020 surveys were conducted on-site. In the case of the 2020 survey, most universities were conducting non-face-to-face classes, but face-to-face classes were available during the final exam period and the survey was conducted in this period. After obtaining the professors' approval, the authors' explained the purpose and method of the study and the rights of being a survey subject. Then, the survey was conducted with students who voluntarily agreed to participate. All surveys followed COVID-19 quarantine guidelines.

Before data collection, Institutional Review Board approval was obtained from Daejeon University to help ensure that the research was conducted in an appropriate manner. Then, data collection was conducted with female students attending a college in cities C or D. In total, 260 students completed the surveys in 2018, and 207 completed the 2020 survey (excluding samples that were judged to have responded unfaithfully to the survey or did not fill out the survey in full).

The variables considered to confirm the characteristics of the research subjects comprised grade, continuous physical activity (more than 30 min at a time, sweating degree, more than three times a week, lasting more than six months), amount of physical activity volume, and depression. The details are shown in Table 1.

Table 1. Characteristics of the research subjects.

Variable	Group	Pre-COVID-19		Post-COVID-19	
		Frequency	Percentage	Frequency	Percentage
Grade	1st Grade	62	23.8	52	25.1
	2nd Grade	81	31.2	64	30.9
	3rd Grade	72	27.7	60	29.0
	4th Grade	45	17.3	31	15.0
Continuous physical activity	Participation	63	24.2	34	16.4
	Non-participation	197	75.8	173	83.6
Amount of physical activity	Low-intensity	112	43.1	128	61.9
	Medium-intensity	103	39.6	57	27.5
	High-intensity	45	17.3	22	10.6
Depression	Not depressed	125	48.1	64	30.9
	Light depression	80	30.8	72	34.8
	Moderate depression	38	14.6	54	26.1
	Severe depression	17	6.5	17	8.2
Total		260	100	207	100

2.2. Research Tools and Reliability

2.2.1. Amount of Physical Activity

The Korean version of the short-message self-encoding questionnaire of the International Physical Activity Questionnaire (IPAQ) was used for the physical activity survey. The IPAQ used in this study comprises four sectors: leisure time, activities at home or outdoors,

work-related activities, and movement-related activities. It records physical activities for seven days. In each sector, the frequency (day/week) and time (min/day) were determined according to the form and type of activity, such as low-, medium-, and high-intensity. The amount of physical activity (MET-min/week) was calculated according to the formulas in Table 2.

Table 2. Formulas used to calculate physical activity.

Category	Equation
Low-intensity	3.3 × walking time (minutes) × walking days
Medium-intensity	4.0 × medium-intensity activity time (minutes) × days of medium-intensity activity
High-intensity	8.0 × high-intensity activity time (minutes) × days of high-intensity activity
Total amount of physical activity	walking + medium-intensity + high-intensity

Furthermore, the level of physical activity of college students was classified into low-, medium-, and high-intensity activity groups according to the degree of physical activity, as depicted in Table 3.

Table 3. Physical activity level classification criteria.

Sortation	Classification Standard
Low-intensity activity	Physical activity not applicable to medium- or high-intensity activities
Medium-intensity activity	One of the following: If high-intensity physical activity (more than 8 METs per minute) was performed for more than 20 min per day on at least three days per week If medium-intensity physical activity (more than 4 METs per minute) was performed for more than 30 min per day on at least five days per week If any combination of exercise and 600 MET-minutes exercise was performed on more than five days per week
High-intensity activity	One of the following: If high-intensity physical activity (more than 8 METs per minute) was performed on at least three days per week for 1500 MET-minutes If a combination of any level of exercise of more than 3000 MET-minutes per week was achieved through daily exercise

2.2.2. Depression Level

The Beck Depression Inventory was used to measure the level of depression. It was developed by Beck, Ward, Mock, and Erbaugh (1961) and adapted by Lee and Song (1991). This depression inventory comprises 21 questions that can confirm the emotional, cognitive, motivational, and physiological symptoms of depression. Each question is presented in a self-report questionnaire, and participants' responses are recorded on a four-point scale from zero to three points. The total score range was 0 to 63, and scores were categorized as follows: 9 points or less = not depressed, 10–15 points = mild depressive, 16–23 points = moderate depressive, and 24–63 points = severe depressive. Table 4 shows the subfactors of depression and reliability confirmed through Cronbach's coefficient.

Table 4. Reliability of the depression test.

Emotional	Number of Questions	Cronbach's α	
		Pre-COVID-19	Post-COVID-19
Emotional	6	0.737	0.710
Cognitive	5	0.707	0.689
Motivational	5	0.651	0.650
Physiological	5	0.635	0.646
Total	21	0.864	0.847

2.2.3. Data Analysis

The data were analyzed using SPSS (version 25.0). First, descriptive statistics were conducted to confirm the characteristics of the participants. Second, a reliability analysis was conducted to verify the reliability of the questionnaire. Third, an independent sample *t*-test was conducted to confirm the changes in physical activity and depression before and after the outbreak of COVID-19. Fourth, a one-way ANOVA was performed to confirm the level of depression according to the amount of physical activity, and a post-test was performed using Tukey's range test. For all analyses, the statistical significance level was set to $\alpha = 0.05$.

3. Results

3.1. Changes in Physical Activity and Depression in Female College Students Due to COVID-19

The total amount of physical activity of female college students decreased from 1672.5 ± 2694.85 before the COVID-19 outbreak to 1198.4 ± 1826.45 after the outbreak. These results indicate a significant decrease, as the probability value was less than 0.05, per the result of the independent sample *t*-test analysis (t = 2.259, $p = 0.024$). All four subfactors of depression (emotional depression, cognitive depression, motivational depression, and physiological depression) increased after COVID-19. Furthermore, as a result of the independent sample *t*-test analysis, the probability value was less than 0.05; thus, all these increases were meaningful (see Table 5).

Table 5. Changes in total physical activity and depression before and after the COVID-19 outbreak.

Factor		Sortation	n	M ± SD	t	*p*
Total physical activity		Before	260	1672.5 ± 2694.85	2.259	0.024
		After	207	1198.4 ± 1826.45		
Depression	Emotional depression	Before	260	2.6 ± 2.28	−3.268	0.001
		After	207	3.3 ± 2.31		
	Cognitive depression	Before	260	2.8 ± 2.46	−2.182	0.030
		After	207	3.3 ± 2.50		
	Motivational depression	Before	260	3.2 ± 2.15	−3.731	0.001
		After	207	4.0 ± 2.24		
	Physiological depression	Before	260	1.8 ± 1.94	−2.320	0.021
		After	207	2.2 ± 2.04		
	Total depression	Before	260	10.6 ± 7.02	−3.673	0.001
		After	207	13.0 ± 6.98		

Sortation: Before = before the COVID-19 outbreak, After = after the COVID-19 outbreak.

3.2. Differences in Depression According to the Physical Activity of Female College Students before and after the COVID-19 Outbreak

In regard to the differences in depression according to the amount of physical activity performed by female college students before and after COVID-19, it was found that the depression of female college students differed according to their level of physical activity;

the depression score of the low-intensity physical activity group was higher than that of the medium-intensity and high-intensity physical activity groups. Accordingly, post-analysis results confirmed a significant difference between the low-intensity and high-intensity physical activity groups ($p < 0.05$).

Female college students' level of depression before the COVID-19 outbreak differed in cognitive depression (F = 7.023, $p = 0.001$) among the subfactors of depression. This difference indicated a higher probability value in the low-intensity physical activity group than in the medium-intensity physical activity group (see Table 6).

Table 6. Differences in depression according to physical activity before and after COVID-19.

Factor		Physical Activity Level (n)			F	*p*	Post Hoc
		Low (112/128) a	Moderate (103/57) b	High (45/22) c			
Emotional depression	Before	2.91 ± 2.16	2.49 ± 2.33	2.48 ± 2.44	1.114	0.330	
	After	3.57 ± 2.15	3.28 ± 2.61	2.50 ± 2.32	2.087	0.127	
	t (*p*)	−2.329 (0.021)	−1.954 (0.052)	−0.018 (0.986)			
Cognitive depression	Before	3.47 ± 2.57	2.61 ± 2.31	2.00 ± 2.17	7.023	0.001	a > b, a > c
	After	3.77 ± 2.49	2.96 ± 2.36	2.18 ± 2.42	5.078	0.007	a > b, a > c
	t (*p*)	−0.915 (0.361)	−0.916 (0.361)	−0.310 (0.758)			
Motivational depression	Before	3.50 ± 2.18	3.18 ± 2.15	2.73 ± 2.00	2.120	0.122	
	After	4.15 ± 1.96	4.19 ± 2.68	2.63 ± 2.19	4.732	0.010	a > c, b > c
	t (*p*)	−2.449 (0.015)	−2.438 (0.017)	0.180 (0.857)			
Physiological depression	Before	1.90 ± 2.26	1.79 ± 1.71	1.73 ± 1.62	0.146	0.864	
	After	2.23 ± 2.10	2.35 ± 2.03	2.18 ± 1.73	0.082	0.921	
	t (*p*)	−1.179 (0.239)	−1.835 (0.068)	−1.036 (0.304)			
The whole depression	Before	11.79 ± 7.46	10.08 ± 6.68	8.95 ± 6.27	3.181	0.043	a > c
	After	13.73 ± 6.51	12.78 ± 7.81	9.50 ± 6.55	3.578	0.030	a > c
	t (*p*)	−2.150 (0.034)	−2.304 (0.023)	−0.329 (0.743)			

Post Hoc: a = low-intensity physical activity group, b = moderate physical activity group, c = high-intensity physical activity group.

After the COVID-19 outbreak, depression in female college students had differences in cognitive (F = 5.078, $p = 0.007$) and motivational (F = 4.732, $p = 0.010$) types of depression among its subfactors. According to the post-test, this difference was higher in the range of meaningful probability values in the case of cognitive depression in the low-intensity physical activity group than in the medium-intensity and high-intensity physical activity groups. Furthermore, in the case of motivational depression, depression was higher in the low-intensity physical activity group than in the moderate physical activity and high-intensity physical activity groups in the range of meaningful probability values. Thus, the level of depression among female college students appeared to vary according to their level of physical activity: specifically, the lower the amount of physical activity, the more severe the depression (see Table 6).

Depression in female college students in the low-intensity physical activity group increased after the COVID-19 outbreak, which differed before and after the COVID-19 outbreak in the range of meaningful probability values (t = −2.150, $p = 0.034$). Among the subfactors of depression, emotional depression (t = 2.329, $p = 0.021$) and motivational depression (t = −2.449, $p = 0.15$), presented differences before and after the COVID-19 outbreak. Depression in female college students in the moderate-intensity physical activity group increased after the COVID-19 outbreak in the range of meaningful probability values (t = −2.304, $p = 0.023$). Among the subfactors of depression, a difference was noted in motivational depression before and after the COVID-19 outbreak (t = −2.438, $p = 0.017$) (see Table 6).

The above results indicate that the depression of female college students belonging to the low-intensity physical activity and the medium-intensity physical activity groups increased after the COVID-19 outbreak.

3.3. Correlation between Physical Activity and Depression in Female College Students Due to the COVID-19 Outbreak

Table 7 confirms the correlation between the physical activity and depression of female college students after the COVID-19 outbreak. The correlation between the amount of physical activity and the level of depression before the outbreak of COVID-19 revealed that the total amount of physical activity and cognitive depression had a negative correlation ($p < 0.01$). In other words, the higher the physical activity level, the less severe the cognitive depression. Furthermore, the correlation between physical activity volume and depression level after the COVID-19 outbreak showed that total physical activity volume was negatively correlated with emotional, cognitive, motivational, and total depression ($p < 0.01$). In other words, the higher the physical activity, the lower the levels of emotional depression, cognitive depression, motivational depression, and total depression.

Table 7. Correlation among physical activity, depression, and interpersonal relationships.

	Factor	1	2	3	4	5	6
pre-COVID-19	1. Total amount of physical activity	1					
	2. Emotional depression	−0.064	1				
	3. Cognitive depression	−0.170 **	0.629 ***	1			
	4. Motivational depression	−0.079	0.626 ***	0.590 ***	1		
	5. Physiological depression	−0.018	0.437 ***	0.339 ***	0.351 ***	1	
	6. Total depression	0.110	0.859 ***	0.831 ***	0.815 ***	0.647 ***	1
post-COVID-19	1. Total amount of physical activity	1					
	2. Emotional depression	−0.085 **	1				
	3. Cognitive depression	−0.265 ***	0.580 ***	1			
	4. Motivational depression	−0.207 **	0.570 ***	0.478 ***	1		
	5. Physiological depression	−0.022	0.439 ***	0.308 ***	0.282 ***	1	
	6. Total depression	−0.229 ***	0.851 ***	0.795 ***	0.765 ***	0.639 ***	1

** $p < 0.01$, *** $p < 0.001$.

4. Discussion

COVID-19, a global infectious disease, has spawned a new phrase, "Corona Blue". The purpose of this study was to provide reference on whether depression can be managed through physical activity by confirming the relationship between depression and physical activity among various psychological conflicts among female college students suffering from COVID-19. This section discusses the results demonstrated in this study.

First, the total physical activity of female college students decreased after the outbreak of the COVID-19 pandemic (t = 2.259, $p = 0.024$). In the case of depression, the subfactors of depression, emotional depression, cognitive depression, motivational depression, and physiological depression increased after the outbreak. Previous studies have shown that physical activity positively affects physical health and that exercising at above-moderate intensity reduces depression and anxiety [38,40]. Furthermore, studies on female college students have found that the higher the participation in physical activities, the higher the self-esteem and the lower the depression [41,42]. The results of these prior studies showed that physical activity and depression are closely related.

With the outbreak and rapid spread of COVID-19, various policies, such as mask mandates, the prohibition of large-scale events, restrictions on private gatherings, and self-isolation or prohibited contact with infected people, have been implemented in Korea.

Thus, most students are forced to spend more time at home because of the implementation of full-scale non-face-to-face classes in elementary, middle, and high schools, as well as universities, to promote social distancing, along with policies, such as reducing operating hours of academies, libraries, and sports facilities. The pandemic has brought about many changes in students' school lives, family lives, and local activities, and sudden environmental changes have likely affected their physical activities and depression.

Moreover, depression among female college students in the low-intensity physical activity and medium-intensity physical activity groups differed before and after COVID-19 ($p < 0.05$). Specifically, there were differences in emotional depression ($p = 0.021$) and motivational depression in the low-intensity physical activity group ($p = 0.015$) and differences in motivational depression in the medium-intensity physical activity group ($p = 0.017$). Specifically, depression scores increased after the pandemic, thereby increasing the overall average depression score of the low- and medium-intensity physical activity groups.

However, in the case of female college students, the current results are consistent with some previous research indicating that the higher the participation in physical activities, the higher the self-esteem and the lower the depression [41,42]. Therefore, it is necessary to find ways to increase physical activity to improve the status of female college students' depression, to get females to practice more intense physical activity, and to establish strategies to improve their personal and social environments, thereby alleviating depression.

Furthermore, Kim, Song, and Jeon (2021) reported that college students in the low-intensity physical activity group showed the most severe level of depression, followed by the high-intensity physical activity group; the least severe depression was found in the medium-intensity physical activity group [43]. The results of previous studies are inconsistent with the results of this study, and we need to explore the reason for this. This inconsistency also means that, when applying physical activity as an intervention variable to lower depression among college students, it is better to set up a customized program considering the individual's physical strength level.

The correlation between physical activity before COVID-19 and depression was also negative when considering total physical activity and cognitive depression ($p < 0.01$). After the COVID-19 outbreak, total physical activity was negatively correlated with emotional depression, cognitive depression, motivational depression, and total depression ($p < 0.01$). These results indicate that depression decreases as physical activity increases. Thus, the significant correlation between cognitive depression and the range of motivational depression probability values after the COVID-19 outbreak should be carefully examined.

The results of this study indicate that, after the COVID-19 outbreak, the amount of physical activity of female college students significantly decreased, thereby increasing the degree of depression. Since 2019, researchers have been looking for ways to overcome COVID-19, but people are now living in an era of "With COVID-19". Thus, it should be acknowledged that, even before the COVID-19 outbreak, the physical activity and depression levels of female college students were already at risk. The number of patients with depression in Korea exceeded 1 million in 2020, 16.8% of whom were in their 20s. Considering that only 9.2% of depression patients were in their 20s in 2010, the proportion of depression patients in their 20s is increasing rapidly [44]. This trend has also been observed in the United States; in 2018, the proportion of people in their 20s suffering from mental stress, such as depression, self-harm, and suicide, nearly doubled compared to 2007 [45].

College students' depression can seriously affect their academic productivity [46], make them decide to drop out of school before graduating [47], and even lead to suicide attempts on campus [48]. According to Korea's National Health Survey [44], people in their 20s showed the highest risk for various indicators, such as depression and suicide, after the pandemic. In this context, various environments related to COVID-19 have significantly influenced the mental health of female college students.

Thus, two years after the COVID-19 outbreak, there is a need to consider physical activity as an intervention variable to reduce depression among female college students.

This is because various studies have shown that physical activity has a very strong effect on human psychological and mental health, thus supporting the necessity of physical activity [29,49,50]. Increasing female college students' participation in physical activity and the amount of physical activity could improve women's health and quality of life.

Therefore, continuous efforts to increase the level of physical activity of female college students from low- to medium-intensity and from medium- to high-intensity are needed. Various efforts at the national, social, and school levels are required in this regard. Establishing and providing systems such as revitalizing university sports, opening liberal arts courses in various sports, promoting the essential completion of liberal arts sports, and increasing time for liberal arts sports, could help female college students prepare to adapt to society challenges brought about by COVID-19.

5. Conclusions

This study examined changes in physical activity and depression among female college students due to COVID-19 and confirmed that these variables are correlated. The following conclusions can be drawn from the results.

First, the total physical activity of female college students decreased due to the COVID-19 outbreak, and depression increased. Second, depression in these students differed according to the level of physical activity performed before and after the COVID-19 outbreak. Third, the amount of physical activity performed and the level of depression were negatively correlated among the participants due to the COVID-19 outbreak. In other words, depression among female college students is related to physical activity. Therefore, encouraging female college students to engage in physical activity can help reduce depression among this group.

Based on these conclusions, subsequent studies need to identify various psychological variables in female college students that could have been affected by the COVID-19 outbreak and further verify their relationships with physical activity. Furthermore, regular physical activity participation, participation time, and participation period could positively affect the psychological change of female college students. As such, further experimental research is needed to confirm the relationship between physical activity and psychological changes.

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