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Original Article

Korean Adolescents before and after COVID-19: Changes in Physical Activity, Mental Health, and Hygiene Management

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Abstract

Background: Adolescence is when health behaviors, namely, physical activity (PA), mental health, and hygiene management, are established. As the young represent our future societal welfare, their health requires attention, particularly in the face of a pandemic. We explored changes in Korean adolescent PA, mental health, and hygiene management before and after the COVID-19 pandemic to identify recommendations for improving adolescent health.

Methods: We collected 2019–2021 data from the Korea Youth Risk Behavior Surveys from the Korea Disease Control and Prevention Agency for 166,590 middle and high school students (2019: 57,069; 2020: 54,809; 2021: 54,712). We analyzed seven variables (regular PA, high-intensity PA, and strength exercise participation, stress recognition, sleep-time satisfaction, brushing practice, and handwashing practice) to examine changes in adolescent behavior during these years.

Results: The findings indicated statistically significant differences in all seven variables over the three years ($P<0.05$). Specifically, regular PA was higher in 2019 and 2021 than in 2020; high-intensity PAs were highest in 2019, followed by 2021 and 2020; strength exercises were the highest in 2020, followed by 2021 and 2019; stress recognition was higher in 2019 and 2021 than in 2020; sleep-time satisfaction was the highest in 2020, followed by 2021 and 2019; brushing practice was the highest in 2019, followed by 2020 and 2021; and handwashing practice was the highest in 2020, followed by 2021 and 2019.

Conclusion: The results recommend the need to encourage structured moderate-to-vigorous adolescent PA and systematic health education to improve Korean adolescent health behavior after COVID-19.

Keywords: Adolescent; COVID-19; Hygiene management; Mental health; Physical activity

Introduction

Since the first outbreak of COVID-19 in China in December 2019, its impact has continued as a global pandemic. The many restrictions that have arisen because of the pandemic, have constrained or eliminated activities usually taken for granted, consequently creating the need to conduct these differently (1). For example, school openings were postponed, online classes were introduced, and sports facilities were closed. As meetings were restricted along with contact with others due to the pandemic, Korean adolescents participated in clas-

ses online at home, rather than in school, and continued to communicate with friends via digital devices.

Adolescence is a period of rapid physical, mental, and social growth in one's lifecycle and is an important time when health behaviors, such as physical activity (PA), mental health, and hygiene management, are established (2). Since healthy behaviors continue into adulthood, healthy adolescents are expected to become healthy adults (3). However, as COVID-19 has increased restrictions not only in school life but also for various activities outside of school, changes have occurred in adolescent health behaviors (4). Not only adolescents have experienced the increased risk of psychological trauma, anxiety, and depression because of COVID-19 but their PA has decreased (5). During the pandemic, adolescents decreased their PA and increased their sedentary time (6). In contrast, the COVID-19 lockdown had positive effects on adolescents, including greater participation in Pas (7). In terms of mental health, for adolescents who usually had difficulties with friendships, school closures during COVID-19 had a positive effect on their mental health by reducing conflicts and bullying (8).

In sum, according to the literature, the health behavior of adolescents changed during COVID-19. Moreover, the results on this vary depending on the study subjects by country; additionally, in the same country, there were differences based on the sample. Each country has a different sociocultural background; specifically, in terms of quarantine guidelines, educational environment, and sanitary environment (9). Within countries, there were also differences depending on age, region, sex, degree of development, existing health status, and economic level of the adolescent (10). One way to improve on the extant literature is to use a nationwide database to examine changes in adolescent health behaviors before and after COVID-19. Exploring changes in Korean adolescent health behavior before and after the pandemic using a large sample can confirm the representation of Korean adolescent PA, mental health, and hygiene management and help establish strategies to improve Korean adolescent health.

Therefore, we aimed to explore changes in PA, mental health, and hygiene management among Korean adolescents before and after the COVID-19 pandemic to identify recommendations for supporting better adolescent health behavior.

Materials and Methods

Study design and participants

We collected data from the 2019 to 2021 KYRBS from the Korea Disease Control and Prevention Agency (KDCA). The KDCA explains the intention of the KYRBS to participants to conduct the survey and receives consent from them and their parents (approval number: 117058). The 2019 survey was conducted in August of that year, and the 2020 and 2021 surveys were conducted in October of each year, respectively. The survey uses a self-administration method, in which the subjects respond directly to the questionnaire. The participants complete the survey using computers or mobile devices at school; and the survey takes about 40 to 50 minutes.

The Ethics Committee of the KDCA exempts the need for ethical approval for the use of KYRBS data, as consent has been given, and the participants are guaranteed anonymity. To conduct our study, we collected KYRBS data from 2019 to 2021. We included data from 166, 590 participants (57,069 in 2019; 54,809 in 2020; and 54,712 in 2021).

Measures

Demographic characteristics

We considered the adolescent's sex, school level, residential area, and age as demographic characteristics. Gender was categorized as "male" and "female;" school level was categorized as "middle school" and "high school;" and residential area was categorized as "urban" and "rural."

PA

For PA variables, we used number of days of regular PA participation, number of days of high-intensity PA participation, and number of days of participation in strength exercises. For number of

days of regular PA, the question was "How many days have you done PA for more than 60 minutes a day in the past week?" Responses to the question were evaluated on a scale (1=none, 2=one day, 3=two days, 4=three days, 5=four days, 6=five days, 7=six days, and 8= every day). The higher the score, the more days the person regularly participated in PAs. For number of days of high-intensity PAs, the question was "How many days did you do high-intensity PAs for more than 20 minutes recently?" While for number of days of strength exercises, the question was "How many days did you do muscle strengthening exercises in the past week?" The responses to the questions were evaluated on a six-point Likert scale (1=none, 2=one day, 3=two days, 4=three days, 5=four days, and 6=five days or more). The higher the score, the more days the adolescent participated in high-intensity PAs and strength exercises for more than 20 minutes.

Mental health

Stress recognition and sleep satisfaction were used as our mental health variables. For stress recognition, the question was, "How much stress do you usually feel?" For sleep-time satisfaction, the question was, "Do you think the time you slept recently is enough to recover from fatigue? " The responses were evaluated on a five-point Likert scale (1=not at all, 2=no, 3=normal, 4=yes, and 5=very much so). The higher the score, the more the adolescents perceived themselves as stressed or getting enough sleep.

Hygiene management

Handwashing and teeth brushing practices were used as the hygiene management variables. The question for handwashing practice was, "How often did you wash your hands using soap before eating at school?" While the question for teeth brushing was, "How often did you brush your teeth after lunch at school?" Responses were rated on a four-point Likert scale (1=not at all, 2=sometimes, 3=mostly, and 4=every day); the higher the score, the better the adolescent was at handwashing and teeth brushing.

Statistical analysis

We used SPSS for Windows (version 23.0; IBM Corp., Armonk, NY, USA) to analyze the data. First, we conducted a frequency analysis and descriptive statistical analysis on adolescents' PAs (regular PA participation, high-intensity PA participation, and strength exercise participation), mental health (stress recognition and sleep-time satisfaction), and hygiene management (brushing and handwashing practices). Second, we conducted a one-way analysis of variance to verify whether there were differences in the seven variables in 2019, 2020, and 2021, before and after the COVID-19 outbreak. The significance level was $P<0.05$. Scheffé's post-hoc analysis was performed on variables that showed statistically significant differences.

Results

The demographic characteristics of the participants are shown in Table 1. Table 2 shows the results of the descriptive statistics analysis (mean, standard deviation, skewness, and kurtosis) of the variables. The univariate normality criteria of skewness (<±3.0) and kurtosis (<±10.0) were satisfied (11).

Table 3 shows the differences in regular PA, high-intensity PA, and strength exercise participation among Korean adolescents over the three-year period; revealing statistically significant differences in regular PA ($F=75.726$, $P<0.001$), high-intensity PA ($F=206.579$, $P<0.001$), and strength exercise participation ($F=56.696$, $P<0.001$).

Table 1: Participants characteristics

Variables		*Total*	*2019 (n=57,069)*	*2020 (n=54,809)*	*2021 (n=54,712)*
Age (yr)		15.051±1.759	14.97±1.776	15.096±1.754	15.092±1.742
Gender	Male	86,279 (51.8)	29,694 (52.0)	28,269 (51.6)	28,316 (51.8)
	Female	80,311 (48.2)	27,375 (48.0)	26,540 (48.4)	26,396 (48.2)
School type	Middle school	88,207 (52.9)	29,299 (51.3)	28,928 (52.8)	29,980 (54.8)
	High school	78,383 (47.1)	27,770 (48.7)	25,881 (47.2)	24,732 (45.2)
Residential area	Urban	84,027 (50.4)	29,234 (51.2)	27,370 (49.9)	27,423 (50.1)
	Rural	82,563 (49.6)	27,835 (48.8)	27,439 (50.1)	27,289 (49.9)

Data are expressed n (%) or mean±standard deviation

Table 2: Descriptive statistics analysis

Variables	*Mean*	*Standard deviation*	*Skewness*	*Kurtosis*
Regular physical activity participation	2.991	2.115	0.927	-0.138
High-intensity physical activity participation	2.770	1.750	0.648	-0.877
Strength exercise participation	2.328	1.727	1.080	-0.220
Stress recognition	3.242	0.966	-0.051	-0.275
Sleep-time satisfaction	2.777	1.126	0.197	-0.649
Brushing practice	2.048	1.177	0.628	-1.166
Handwashing practice	2.662	1.009	-0.115	-1.109

Table 3: Differences in physical activity participation over the three years

Item	*Variables*	*Average*	*Standard deviation*	*Standard error*	*F*	*P*	*Post-hoc (Scheffe test)*
Regular physical activity participation	2019 (a)	3.024	2.127	0.009	75.726	<0.001***	a,c>b
	2020 (b)	2.901	2.124	0.009			
	2021 (c)	3.047	2.090	0.009			
High-intensity physical activity participation	2019 (a)	2.858	1.757	0.007	206.579	<0.001***	a>c>b
	2020 (b)	2.650	1.754	0.007			
	2021 (c)	2.797	1.734	0.007			
Strength exercise participation	2019 (a)	2.272	1.688	0.007	56.696	<0.001***	b>c>a
	2020 (b)	2.379	1.771	0.008			
	2021 (c)	2.306	1.721	0.007			

****P*<0.001, tested by one-way analysis of variance

Table 4 shows the differences over the three years in Korean adolescents' stress recognition and sleep-time satisfaction; revealing statistically significant differences in stress recognition (F=236.526, *P*<0.001) and sleep satisfaction (F=936.431, *P*<0.001), depending on the year.

Table 5 shows the differences over the three years in terms of teeth brushing and hand washing practices; revealing statistically significant differences in teeth brushing (F=2294.730, *P*<0.001) and handwashing practice (F=1257.861, *P*<0.001), depending on the year.

Table 4: Differences in mental health over three years

Item	*Variables*	*Average*	*Standard deviation*	*Standard error*	*F*	*P*	*Post-hoc (Scheffe test)*
Stress recognition	2019 (a)	3.285	0.989	0.004	236.526	<0.001***	a,c>b
	2020 (b)	3.169	0.942	0.004			
	2021 (c)	3.274	0.962	0.004			
Sleep-time satisfaction	2019 (a)	2.671	1.121	0.005	936.431	<0.001***	b>c>a
	2020 (b)	2.944	1.134	0.005			
	2021 (c)	2.721	1.103	0.005			

****P*<0.001, tested by one-way analysis of variance

Table 5: Differences in hygiene management over the three years

Item	*Variables*	*Average*	*Standard deviation*	*Standard error*	*F*	*P*	*Post-hoc (Scheffe test)*
Brushing practices	2019 (a)	2.246	1.194	0.005	2294.730	<0.001***	a>b>c
	2020 (b)	2.104	1.189	0.005			
	2021 (c)	1.785	1.097	0.005			
Handwashing practice	2019 (a)	2.521	0.967	0.004	1257.861	<0.001***	b>c>a
	2020 (b)	2.821	1.012	0.004			
	2021 (c)	2.650	1.027	0.004			

***P<0.001, tested by one-way analysis of variance

Discussion

The results are divided into PA, mental health, and hygiene management. First, there was a statistically significant difference in adolescent participation in PAs over the three years 2019 to 2021. Regular participation of adolescents in PAs was higher in 2019 and 2021 than that in 2020. The implication is the peak of the COVID-19 pandemic in 2020 created restrictions on adolescent participation in regular PAs. COVID-19 social distancing has reduced the number of days adolescents participate in regular PAs, supporting our findings here (5, 6, 12). As existing school physical education classes have always played an important role in promoting adolescent PA, the lack of such activities can be inferred from the relative increase in non-face-to-face activities and decreased interactions among school peers after COVID-19 began (13). Participation in high-intensity PAs was the highest in 2019, followed by 2021 and 2020. The implication is that there was a decrease in participation in high-intensity PAs because of COVID-19 in 2020, with these habits continuing in 2021. In addition, our results show that even before COVID-19, Korean adolescents participated in high-intensity PAs only for an average of one to two days per week. These results are far below the WHO standard (14), which recommends intense PA of about 60 minutes a day. With the onset of COVID-19, adolescent participation in high-intensity PAs has only gotten worse. Accordingly, the Korean Ministry of Education will need to come up with practical measures to revitalize high-intensity PA among adolescents.

On a positive note, participation in strength exercise was the highest in 2020, followed by 2021 and 2019. The implication is that such exercises increased among adolescents during COVID-19. In Korea, distancing was emphasized in accordance with the COVID-19 quarantine guidelines and adolescents were encouraged to participate in PAs

online at home rather than at school, since they went to school possibly every other day or every other week, with the pattern of class operation changing. Prior to COVID-19, middle and high school physical education classes in Korea were mostly activities with friends in school gyms or on playgrounds. However, after COVID-19, middle and high school physical education classes were more focused on strength training, such as dumbbell exercises, push-ups, and sit-ups, which adolescents can perform alone with limited restrictions at home (15). The pattern of physical education classes in middle and high schools in Korea, which changed owing to COVID-19, had a statistically significant effect on adolescent participation in strength exercises (15).

Second, there were statistically significant differences in the mental health of adolescents over the three years. Stress recognition is higher in 2019 and 2021 than in 2020. Interestingly, this contrasts with the results of several extant studies (5, 19) that show that the stress index of adolescents increased immediately after COVID-19. Meanwhile, sleep-time satisfaction was highest in 2020, followed by 2021 and 2019. Şimşek et al (16) supports our results, claiming that COVID-19 increased the amount and quality of sleep people received, as they were spending more time at home. According to our results, the decrease in stress and the high satisfaction with sleep time among Korean adolescents immediately after the COVID-19 pandemic implies a temporary positive change in their lives, when their lives often are centered on entrance exams (17). Generally, Korean adolescents face extensive pressure to study, which means spending a significant amount of time at school or attending academies until late at night; both of which cause sleep deprivation and stress (18). The closure of schools due to COVID-19 is believed to have affected the results, as the burden of academic achievement for adolescents temporarily decreased, reducing stress recognition and increasing sleep-time satisfaction compared with pre-COVID-19.

Third, adolescent teeth brushing practices were the highest in 2019, followed by 2020 and 2021. Korea implemented mandatory mask wearing per the COVID-19 quarantine guidelines. This banned adolescents from brushing their teeth in school and increased the incidence of tooth decay among adolescents (20). It is likely that the situation in Korea influenced these results. In addition, handwashing practices were the highest in 2020, followed by 2021 and 2019. Handwashing was the best hygiene management method for preventing infectious diseases, as 70% of infectious diseases can be prevented with proper handwashing (21). Accordingly, the Korean Ministry of Education emphasized hygiene education for adolescents and specifically promoted combining theory with practice for handwashing, disinfection of objects, and the wearing of masks. Thus, the implication is that continuous health education on this during the COVID-19 pandemic increased the practice of handwashing among adolescents.

Based on the results, the recommendations for promoting health behaviors among Korean adolescents are as follows: First, the Korean Ministry of Education should strengthen school sports activities to promote MVPA among adolescents. Our results confirm that the level of PA of Korean adolescents does not meet the WHO's recommended exercise guidelines. This was true not only after the outbreak of COVID-19 but also before the outbreak, in 2019. Thus, we should find ways to increase the MVPA of Korean adolescents through school sports. MVPA is considered more than 3 metabolic equivalents of energy metabolism and refers to a certain intensity of PA, such as jumping rope quickly, fast walking, or active competitive sport participation, such as tennis, badminton, and soccer (22). MVPA occurs more frequently in structured PA environments than in unstructured ones (e.g., lunchtime or break time) (23). The implication is that the Korean Ministry of Education should create and support environments where adolescents can engage in more MVPA. Specifically, expanding school-based physical education activities can increase the feasibility of MVPA. This is because adolescent MVPA is acutely affected by the organized PA programs provided in schools. In particular, physical education classes represent 26-34% of adolescents' daily PA and 16.5%-17.8% of their daily MVPA (24).

Possible options for expanding MVPA include weekend sports activities, improving and expanding after-school sports clubs, and offering free physical fitness classes before and after school. Additionally, adolescent PA could be increased by encouraging local adolescents to run Saturday sports activities or by providing various morning sports activities before class. Moreover, sports club participation in connection with a private sports club, could supplement adolescent MVPA, which may be insufficient only with school physical education classes, using times other than regular classes. The Whole-of-School approach, which states that students should be active before, during, and after school, supports the claim that the guideline of 60 minutes of MVPA per day can be met through activities in the "0th period" before school and then after school through structured physical education (25). Notably, this recommendation requires an expanded role for physical education teachers, who would be responsible for directing and planning PAs to ensure maximum opportunities for adolescents to participate in before- and after-school activities (26). Accordingly, physical education teachers would need to develop their expertise through training at the Office of Education and by practicing in the teacher-learning community to strengthen their capabilities.

Second, systematic guidance on health education should be recommended at an early age. Our results show a statistically significant difference in handwashing practices among adolescents before and after COVID-19. The implication is that this resulted from the emphasis on handwashing education among adolescents at school during COVID-19. However, adolescents may feel bored, as they have to deal with health education-related content on multiple subjects (27). One reason for this is that there is no separate dedicated health curriculum in Korea. Thus, health education topics, such as sports, health, and safety, are presented separately in various classes, making it less systematic. This aspect of the Korean curriculum can cause overlapping problems of providing redundant information in different classes or the side effect of boring students. Thus, our recommendation for Korea is to outline the content and revise the curriculum to include specific classes that offer a comprehensive guide to health education.

Korea had an opportunity to improve on the problems of health education by revising the national-level curriculum in 2022. However, it remains on the verge of continuing in an unsystematic state without universal health education courses and related curriculum modifications (28). In the Korean 2022 revised curriculum, physical education does focus on health education. However, it only begins in the third grade of elementary school. Thus, students in the younger grades do not learn information related to health education until third grade. Health education is continuously provided in the United States from infancy through the lower grades to the upper grades. Moreover, the National Health Education Standards (NHES) present health-related goals and systematically present what to learn by grade to achieve these goals (29). Australia also offers an in-depth approach to health education in its curriculum called "Health and Physical Education," which includes major healthcare content to be learned by grade (30). Therefore, the recommendation is that in Korea, health education should be presented in the curricula to lay the foundation for a healthy life through systematic health education from an early age.

This study has several limitations, which can be addressed in subsequent studies. First, as we studied Korean adolescents, the results cannot be generalized to other cultures or age groups. A follow-up study is required to explore changes in health behavior in Korean adults. Second, since we used quantitative research methods, changes in adolescent health behaviors were only identified numerically. A subsequent study should reflect adolescent thoughts and opinions on health behavior more comprehensively during the COVID-19 pandemic by including qualitative data, such as in-depth interviews. Third, we used only three variables (PA, mental health, and hygiene) to explore the health behaviors of adolescents before and after COVID-19. However, various other variables of adolescent health behavior, such as smoking, drinking, and diet that could be considered. Thus, adolescent health behavior should be analyzed

more broadly by adding variables in subsequent studies.

Despite these limitations, our study contributes to the literature by capturing the changes in PA, mental health, and hygiene management among Korean adolescents before and after the COVID-19 pandemic.

Conclusion

We explored changes in the PA, mental health, and hygiene management of adolescents before and after the COVID-19 pandemic. Over the three years from 2019 to 2021, there were statistically significant differences in adolescent regular PA, high-intensity PA, and strength exercise participation, stress recognition, sleep-time satisfaction, brushing practice, and handwashing practice. Our results recommend the need for a more systematic implementation of adolescent MVPA that includes structured activities that supplement school physical education classes, as well as systematic health education.

Journalism Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of Interest

The author declares no conflicts of interest.

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